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REMEDIAL INVESTIGATION FEASIBILITY STUDY WORK PLAN FOR SITE ST16 BASE SERVICE STATION NAS FORT WORTH TX
3/1/1993
ARMY CORP OF ENGINEERS

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NAVAL AIR STATION
FORT WORTH JRB
CARSWELL FIELD
TEXAS

ADMINISTRATIVE RECORD
COVER SHEET

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CARSWELL AIR FORCE BASE

REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS) WORK PLAN

for

SITE ST16 BASE SERVICE STATION

PREPARED BY:

U.S. ARMY CORPS OF ENGINEERS
Fort Worth District

MARCH 1993

PREPARED FOR:

CARSWELL AIR FORCE BASE
TEXAS

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1.0 Description of Installation.

Carswell AFB is located on 2,751 acres of land in Tarrant County, Texas, 6 miles west of the center of Fort Worth and lies between the communities of White Settlement and River Oaks. Carswell AFB lies within a bend of the West Fork of the Trinity River which flows along the northern and eastern boundaries of the base. The river is dammed to form Lake Worth, a drinking water supply and recreation reservoir bordering Carswell AFB to the north. To the west, Carswell AFB is neighbored by Air Force Plant 4, an Air Force-owned, General Dynamics Corporation-operated, aircraft production plant that shares the runway and several facilities with Carswell AFB. To the south Carswell AFB is bordered by urban areas. Off-base facilities include the Intermediate Landing System (ILS) Marker Beacon west of Carswell AFB and the Weapons Storage Area (WSA), 4 miles west of Carswell AFB.

Carswell AFB is the home of the Strategic Air Command's (SAC) 7th Bombardment Wing. As such, the mission of Carswell AFB is to maintain the capability of strategic warfare and air refueling operations. Assigned weapon systems include the Boeing B-52H bomber and the KC-135A tanker.

As host unit, the 7th Bombardment Wing oversees aircraft operations and maintenance agencies. In addition to maintaining bombers, tankers, and combat crews capable of strategic warfare, Carswell AFB also houses an extensive air training effort which includes the air training requirements of three tactical squadrons. The 7th Combat Support Group and the USAF Regional Hospital support the combat mission of the Wing. The total work force at Carswell AFB (as of 1984) was approximately 5,100 military and 1,000 civilian personnel.

2.0 Environmental Setting.

The following discussion of the Carswell AFB environmental setting is derived primarily from the Installation Restoration Program Phase I Records

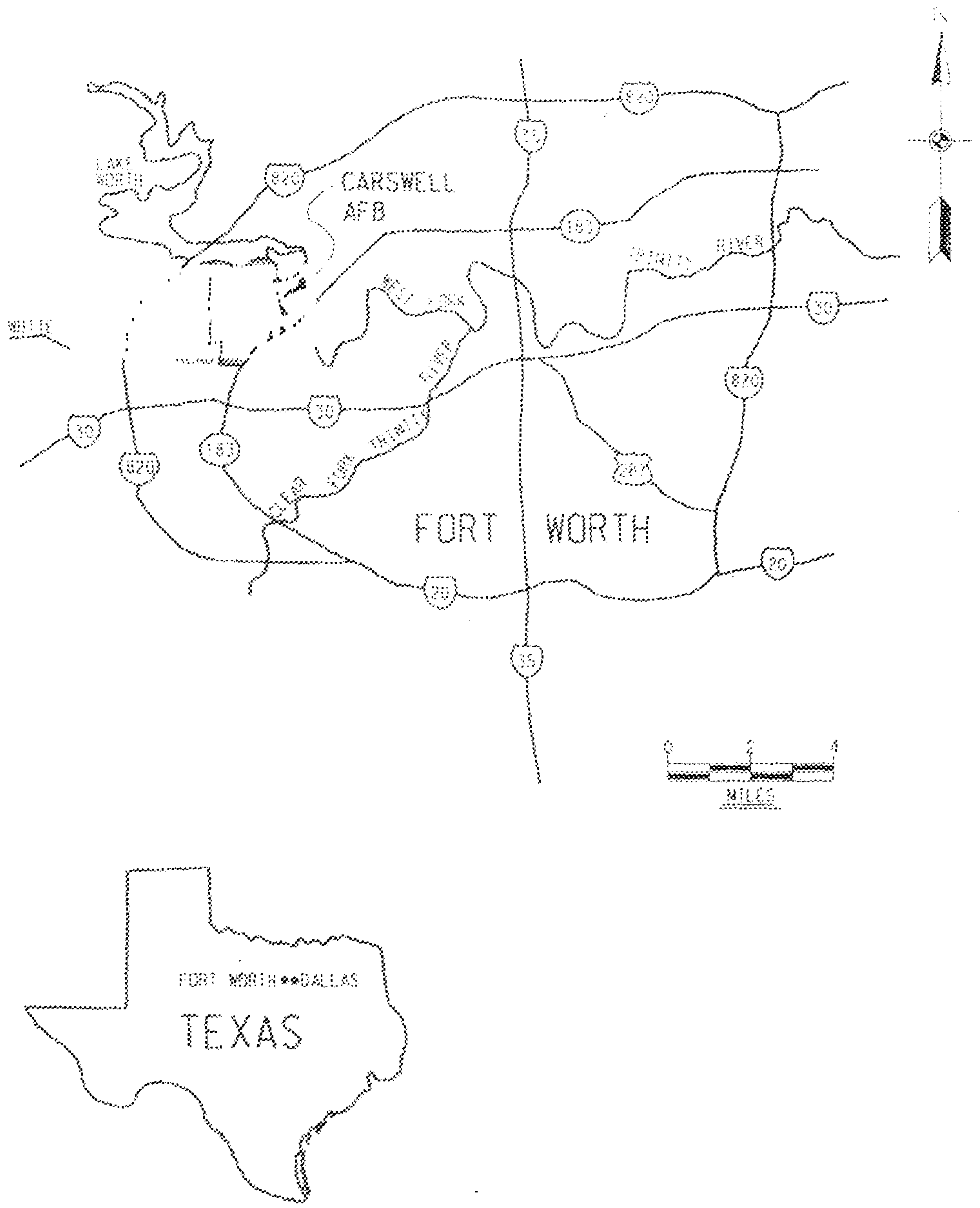
Search Report (CH2M Hill, 1984). Information from that report is supplemented by information from the literature and from the general findings of studies conducted by the Radian Corporation. The following sections describe the environmental setting of Carswell AFB. Basic features and history of the site investigated in this work plan are also discussed below.

2.1 __Geophysical Setting__. Carswell AFB is located in northeastern Texas in Tarrant County, six miles west of downtown Fort Worth (Figure 1). The base is bordered by Lake Worth to the north, the West Fork of the Trinity River and the community of Westworth to the east and southeast, the community of White Settlement to the south and southwest and Air Force (AF) Plant 4 to the west. The location of Carswell AFB is shown in Figure 2.

The base lies within an area of primarily residential, recreational, and industrial/commercial land use. The principal industrial use of the area is Air Force Plant 4, an aircraft production plant that borders Carswell AFB to the west and shares the runway with the base. Recreational land use includes the Y.M.C.A's Camp Carter, and various parks on the shores of Lake Worth.

2.1.1 __Physiography__. The majority of Carswell AFB is located within the Grand Prairie section of the Central Lowlands Physiographic Province. This area is characterized by broad terrace surfaces sloping gently eastward, interrupted by westward-facing escarpments. The land is typically grass covered and treeless, except for isolated stands of upland timber. The northwestern part of Carswell AFB is within the Western Cross Timbers Physiographic Province that is characterized by rolling topography and a heavy growth of post and black-jack oaks.

2.1.2 __Topography__. The topography of the base is fairly flat except for areas near Farmers Branch and the Trinity River. Land surface slopes gently northeast toward lake Worth and east toward the West Fork of the



CARSWELL AIR FORCE BASE, TEXAS
REGIONAL SETTING
FIGURE 1

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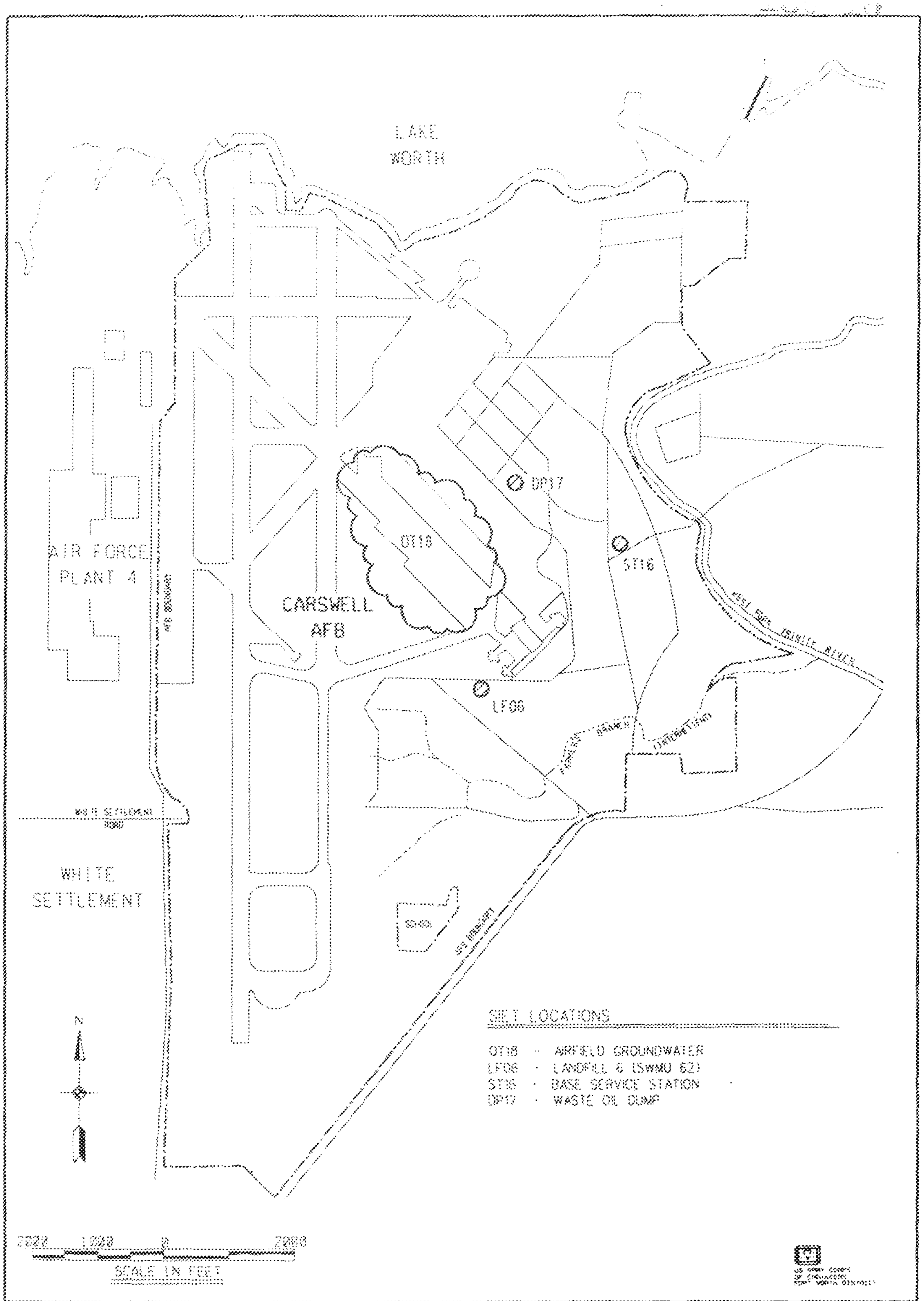


CARSWELL AIR FORCE BASE, TEXAS
RI/FS WORKPLAN SITE LOCATIONS
FIGURE 2

Trinity River. Elevations on base range from a high of approximately 690 feet above mean sea level (msl) at the southwest corner of the base to a low of approximately 550 feet msl at the east side of the base. The elevation of Lake Worth usually approximates the elevation of the dam spillway, 594 feet msl.

The principal drainage for Carswell AFB is the West Fork of the Trinity River. Farmers Branch drains the southern portion of the base, but in turn discharges into the Trinity. A small portion of the north end of the base drains into Lake Worth.

2.2 Geology.

2.2.1 Surficial Soils. The U.S.D.A. Soil Conservation Service has identified four soil associations at Carswell AFB. The soils are described in Table 1, and their occurrences on base are shown on Figure 3. The surficial soils of the installation area are primarily nearly level to gently sloping clayey soils of the Sanger-Purves-Slidell and Aledo-Bolar-Sanger Associations. In addition to the above, the clayey soil of the Frio-Trinity Association and the loamy soil of the Bastsil-Silawa Association occur on the floodplain and stream terraces of the West Fork of the Trinity River.

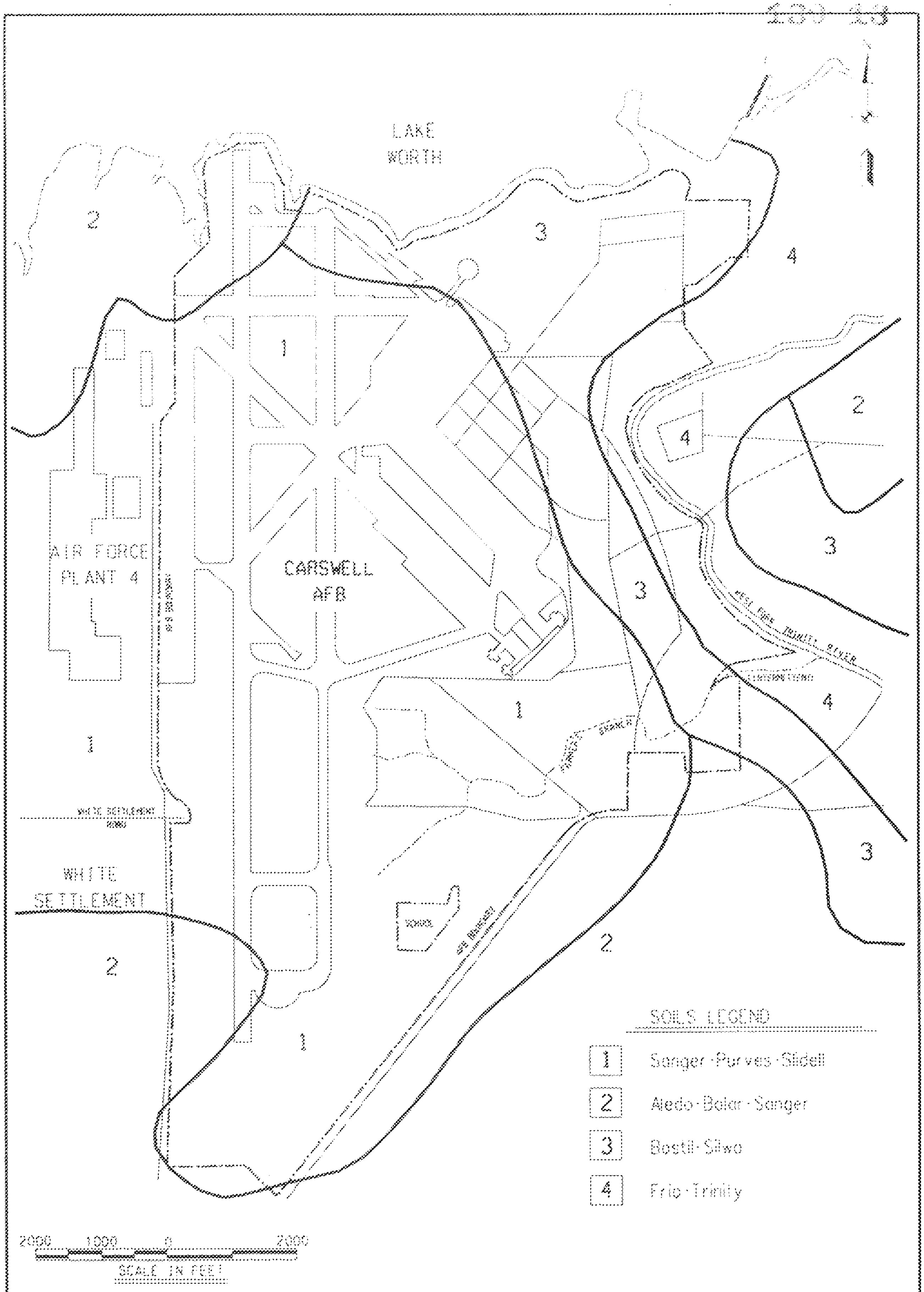
2.2.2 Lithology. A geologic section showing the rock formations beneath Carswell AFB is presented in Figure 5. Descriptions and properties of units pertinent to this study are summarized in Table 2. From youngest to oldest, the geologic units of interest to Carswell AFB are as follows: (1) Quaternary Alluvium, (2) Cretaceous Goodland Limestone, (3) Cretaceous Walnut Formation, (4) Cretaceous Paluxy Formation, (5) Cretaceous Glen Rose Formation, and (6) Cretaceous Twin Mountains Formation. The occurrence of these units on base is shown on a geologic map, Figure 4.

TABLE 1

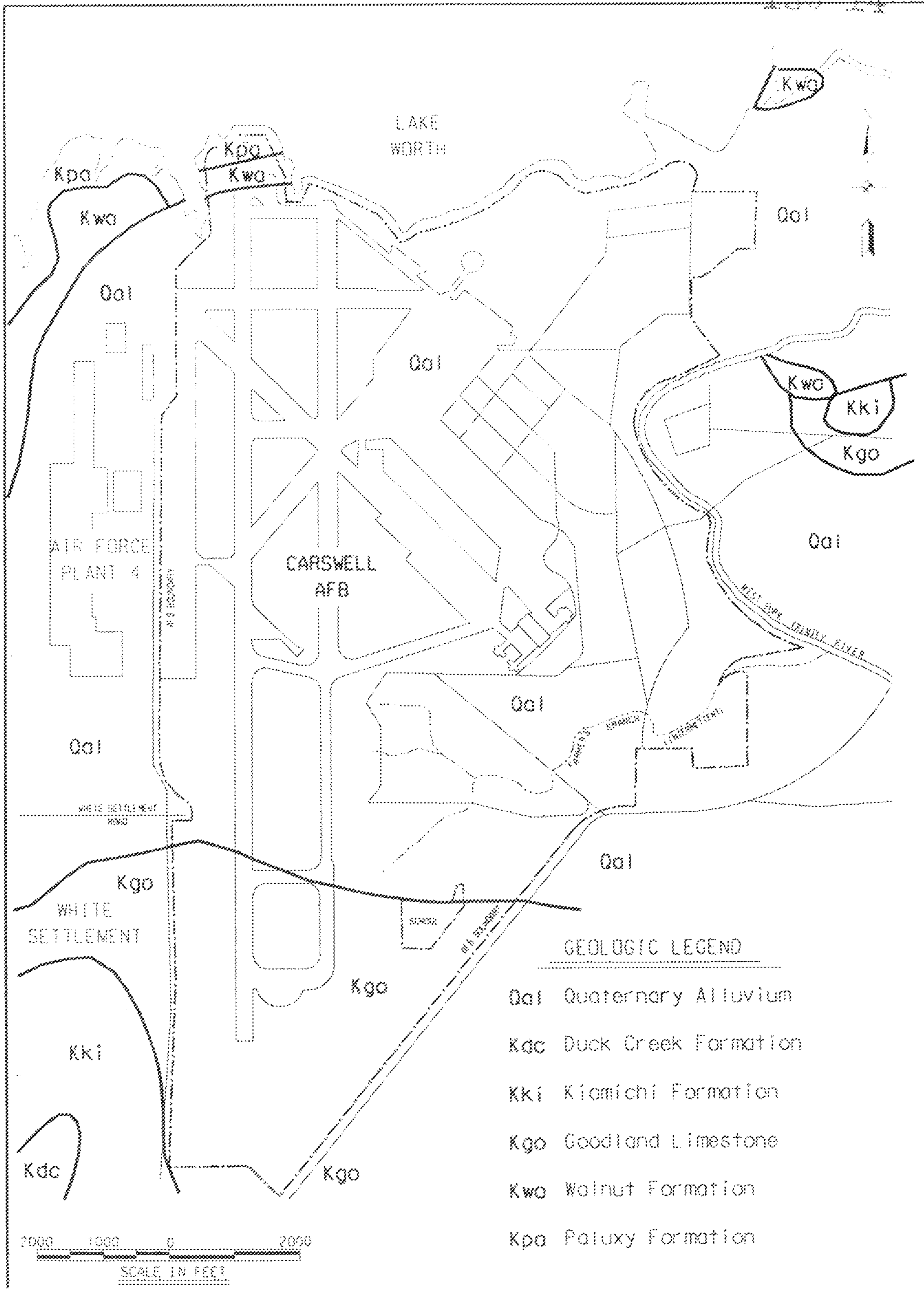
SOILS ASSOCIATIONS FOR CARSWELL AFB, TX

Association	Description	Thickness (inches)	Permeability (cm/sec)
Sanger-Purves-Slidell: Clayey soils of nearly level to gently sloping uplands	Clay loam Clay over bedrock Silty clay	8-80	$<4.2 \times 10^{-5}$ to 3.0×10^{-4}
Aledo-Bolar-Sanger: Loamy and clayey soils of gently sloping to moderately steep uplands	Clay loam over bedrock Clay loam	8-70	$<4.2 \times 10^{-5}$ to 9.0×10^{-4}
Frio-Trinity: Clayey soil on nearly level flood plains	Silty clay loam Clay	25-75	$<4.2 \times 10^{-5}$ to 3.0×10^{-4}
Batasil-Silawa: Loamy soils on nearly level to sloping stream terraces	Sandy clay loam	40-80	9.0×10^{-4} to 3.0×10^{-3}

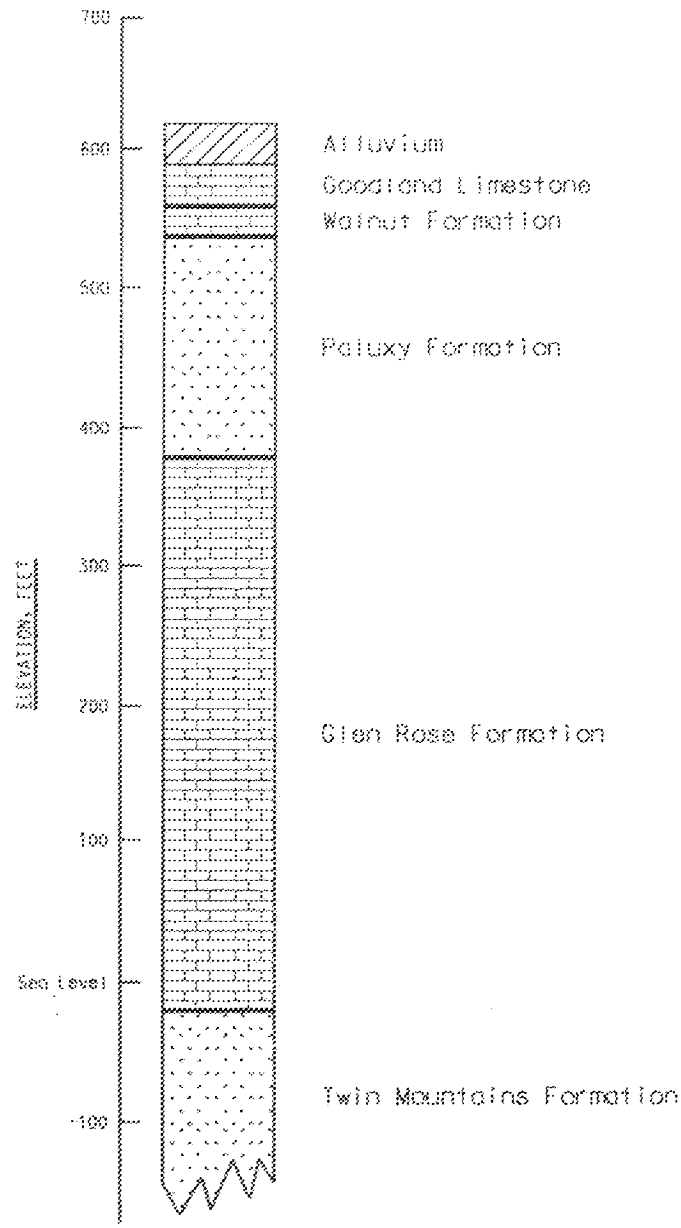
SOURCE: U.S. Department of Agriculture, 1981 Soil Survey of Tarrant County: Soil Conservation Service, 219 pp.



CARSWELL AIR FORCE BASE, TEXAS
SOILS ASSOCIATION MAP
FIGURE 3



CARSWELL AIR FORCE BASE, TEXAS
GEOLOGIC MAP
FIGURE 4



CARSWELL AIR FORCE BASE, TEXAS
STRATIGRAPHIC COLUMN
FIGURE 5

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TABLE 2

GEOLOGIC FORMATION BENEATH CARSWELL AFB, TEXAS

System	Series and Group	Formation and Number	Thickness (ft)	Character of Rocks	Topographic Expression	Water-Bearing Properties
Quaternary	Recent and Pleistocene	Alluvium	0-45	Sand, gravel clay and silt	Terrace and flood plain deposits.	Small to moderate yields. Water unsatisfactory for use unless treated.
Cretaceous	Comanche Series Washita Group	Duck Creek Formation	0~80	Impure limestone and marl, which is blue when fresh and straw colored when weathered. Fossiliferous with distinctive ammonites	Bench topography produced by lower limestone unit. Upper marl forms slope separating the Duck Creek from Fort Worth limestone.	Small to moderate yields. Water unsatisfactory for use unless treated.
	Comanche Series Fredericksburg Group	Kiamichi Formation	0~40	Blue and brownish-yellow marl, thin limestone and sandstone flags.	Grassy slope separating scarps of Goodland and Duck Creek formations.	Small to moderate yields. Water unsatisfactory for use unless treated.
		Goodland Limestone	0~130	Chalky-white fossiliferous limestone, and blue to yellowish-brown marl.	Prominent glaring-white escarpment along streams.	Small to moderate yields. Water unsatisfactory for use unless treated.
		Walnut Clay	0~30	Shell agglomerate fossiliferous clay and limestone, sandy clay, and black shale.	Forms conspicuous escarpment and waterfalls in western Cross Timbers belt.	Not known to yield water to wells in Tarrant County.
UNCONFORMITY						
Cretaceous	Comanche Series Trinity Group	Paluxy Sand	140~190	Fine-grained sand, shale, sandy shale, lignite and pyrite.	Sandy soil, hummocky topography, heavily wooded with oaks.	Sources of supply for most households, smaller cities, and some industries.
		Glen Rose Limestone	250~450	Fine-grained limestone, marl, and sandstone.	Not exposed in Tarrant County.	Sands yield small supplies to wells in Fort Worth and western Tarrant County. Water too highly mineralized east of Fort Worth.
		Twin Mountains Formation (formerly Travis Peak formation)	250~430	Coarse to fine-grained sandstone, red shale, red and yellow clay at base.	Not exposed in Tarrant County.	Principal aquifer in Tarrant County. Yields large supplies for municipal and industrial purposes. Water in upper sands east of Fort Worth may be highly mineralized.
MAJOR UNCONFORMITY						
Pennsylvanian	Undifferentiated		3000~7000	Gray, sandy shale, tight quartzitic sandstone, black limestone. Probably represents Strawn formation.	Not exposed in Tarrant County.	Not tested. Probably would not yield fresh water.

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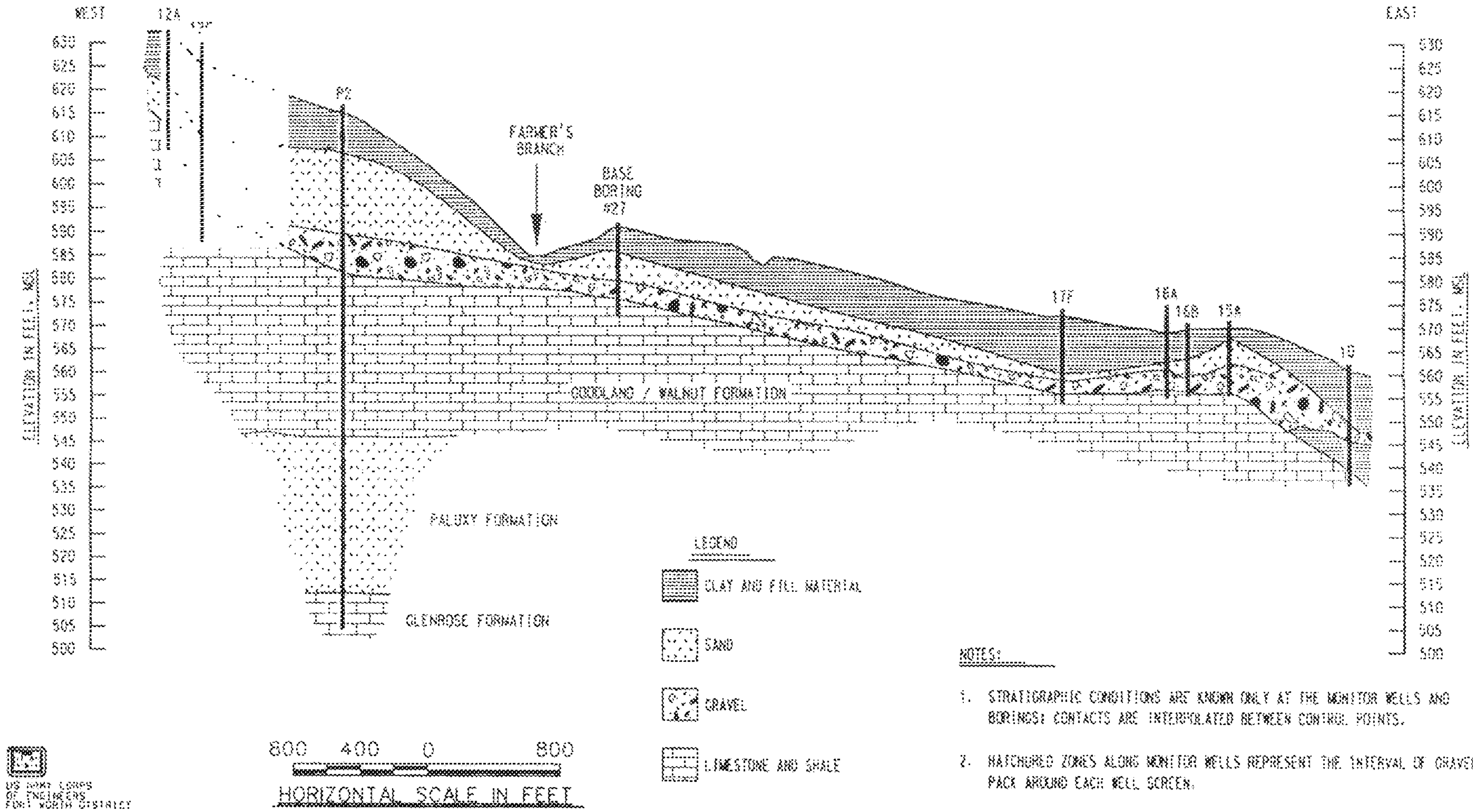
The majority of the base is covered by alluvium deposited by the Trinity River. The alluvium is composed of gravel, sand, silt, and clay of varying thicknesses and lateral extents. The Goodland Limestone is exposed on the southern portion of the base, south of White Settlement road. The Goodland is a chalky-white, fossiliferous limestone and marl. A small area exposing the Walnut and Paluxy Formations occurs in the northwestern corner of the base along the shores of Lake Worth. The Walnut Formation is a shell-agglomerate limestone with varying amounts of clay and shale. The Paluxy Formation is primarily a fine- to coarse-grained sand with minor amounts of clay, sandy clay, pyrite, lignite, and shale. Neither the Glen Rose Limestone, nor the Twin Mountains Formation are exposed at Carswell AFB.

2.2.3 Structure. Carswell AFB is located on the relatively stable Texas craton, west of the faults that lie along the Ouachita Structural Belt. No major faults or fracture zones have been mapped near the base. The regional dip of the rocks beneath Carswell AFB is between 35 and 40 feet per mile in an easterly to southeasterly direction. The stratigraphic and structural relationships of the uppermost geologic units at Carswell AFB are illustrated in Figure 5A. The geologic cross section was taken from a southwest to northeast direction across the southern portion of the base.

2.3 Hydrogeology.

2.3.1 Surface Water. Carswell AFB is located within the Trinity River Basin just south of Lake Worth, a man-made reservoir on that river. Part of the base is drained by Framers Branch which discharges into the West Fork Trinity River just south of the cantonment area. Farmers Branch begins within the community of White Settlement and flows eastward. Just south of Air Force Plant 4, Farmers Branch flows under the runway within two large culverts.



NOTES:

1. STRATIGRAPHIC CONDITIONS ARE KNOWN ONLY AT THE MONITOR WELLS AND BORINGS; CONTACTS ARE INTERPOLATED BETWEEN CONTROL POINTS.
2. HATCHURED ZONES ALONG MONITOR WELLS REPRESENT THE INTERVAL OF GRAVEL PACK AROUND EACH WELL SCREEN.

CARSWELL AIR FORCE BASE, TEXAS
TYPICAL GEOLOGIC CROSS SECTION
FIGURE 5A

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Most of the base surface drainage is intercepted by a series of storm drains and culverts, directed to oil/water separators and discharged to the West Fork Trinity River downstream of Lake Worth. A small portion of the north end of the base drains into Lake Worth.

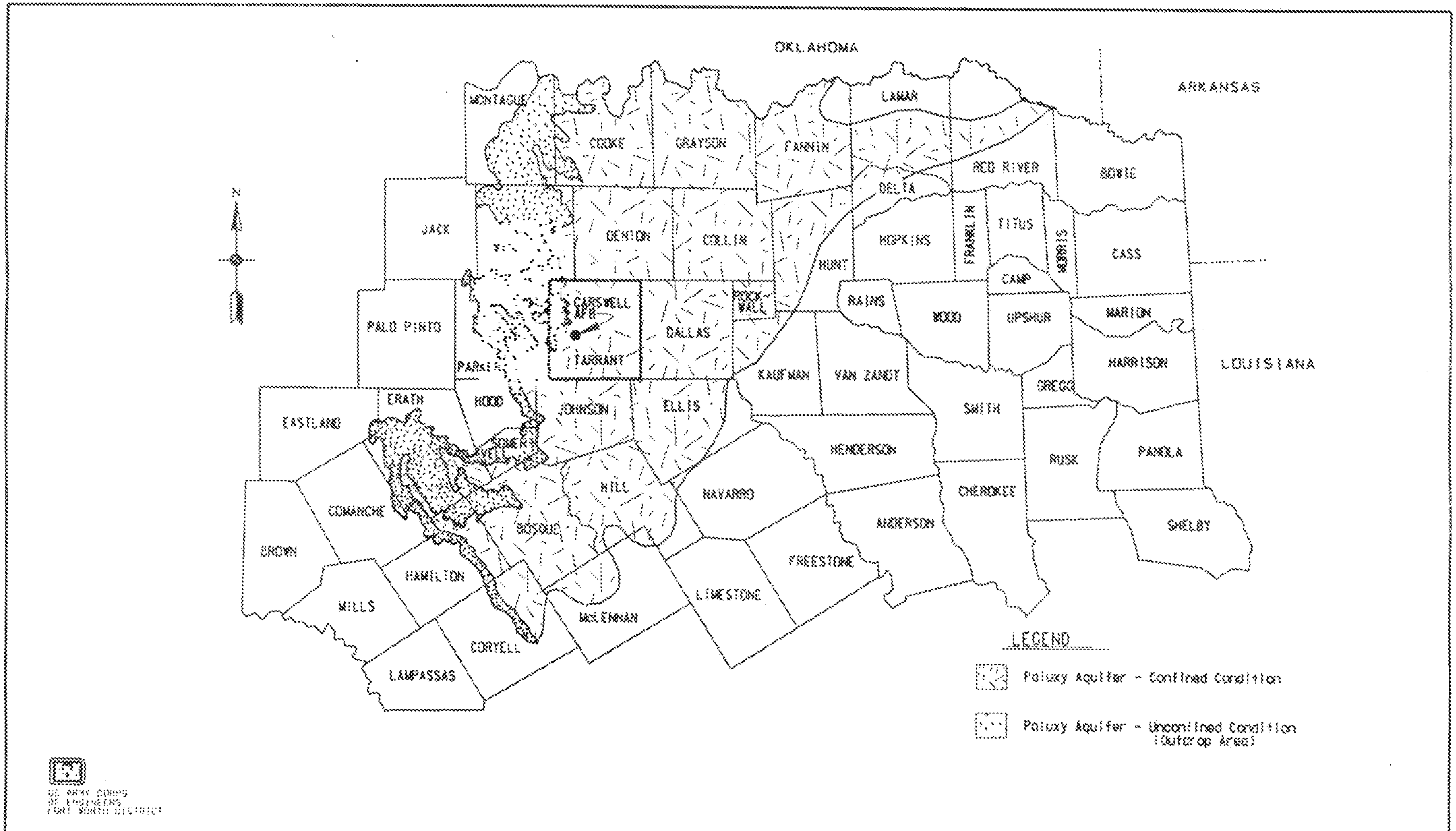
2.3.2 <u>Groundwater</u>. On the basis of their water-bearing properties, the geologic units at Carswell AFB may be divided into the following five hydrogeologic units, listed from most shallow to deepest: (1) an upper perched-water zone occurring in the alluvial terrace deposits left by the Trinity River; (2) an aquitard or predominantly dry limestone of the Goodland and Walnut Formations; (3) an aquifer in the Paluxy sand; (4) an aquitard of relatively impermeable limestone in the Glen Rose Formation; and (5) a major aquifer in the sandstone of the Twin Mountains Formation. Each of these units is examined in more detail below.

2.3.2.1 <u>Upper Zone</u>. Groundwater occurs within the coarse sand and gravels deposited by the Trinity River, but these deposits are usually limited in areal extent and isolated by surrounding low-permeability clays and silts. Recharge to the water-bearing deposits is local, from rainfall and infiltration from stream channels and drainage ditches. Water flow in the alluvium is basically eastward, toward the West Fork of the Trinity River.

In parts of Tarrant County, generally close to the Trinity River, water in the alluvium is developed for irrigation and residential use. The community of River Oaks, immediately east of Carswell AFB, had supply wells that developed water from the alluvial deposits at a location near the USAF hospital. The wells were abandoned when Carswell AFB purchased the property for hospital construction. For the most part, groundwater is not economical to develop from the alluvium due to the limited distribution of the water and susceptibility to surface/storm water pollution.

2.3.2.2 <u>Goodland/Walnut Aquitard</u>. The perched water present in the alluvium is separated from the aquifers below by the low permeability limestones and shales of the Goodland Limestone and Walnut Formation. The aquitard is composed of moist clay and shale layers interbedded with dry limestone beds. Though primarily dry, drillers in the area report that small amounts of water enter the borehole while drilling through the Walnut Formation, suggesting that groundwater may move through the Walnut along bedding planes (Hargis and Associates, Inc., 1984). The thickness of the Goodland/Walnut aquitard is approximately 25 feet or greater beneath most of Carswell AFB. However, the top of the aquitard is an erosional surface and weathering may have reduced the thickness of the limestone in isolated areas. A soil boring at Air Force Plant 4, across the runway to the west from Carswell AFB, revealed that the Goodland Limestone had been completely eroded and only 3 feet of the Walnut Formation remained (Hargis and Associates, Inc., 1984). It is also reported that the upper zone and Paluxy Formation are in contact at the eastern boundary of AF Plant 4, where both the Goodland and Walnut Formations have been removed by erosion (Hargis and Associates, 1985). In areas of similarly extensive erosion, water in the upper zone could come in contact with water in the Paluxy aquifer.

2.3.2.3 <u>Paluxy Aquifer</u>. The Paluxy aquifer is the most shallow aquifer occurring beneath Carswell AFB. The aquifer's area extent is shown in Figure 6. In the base area, water in the Paluxy would naturally occur under confined conditions beneath the Goodland/Walnut aquitard (except where the aquitard is missing due to erosion, as discussed above). However, extensive pumping in the Fort Worth area has lowered the Paluxy potentiometric surface below the top of the formation, resulting in unconfined conditions beneath the base. The Paluxy Formation is divided into upper and lower sand members and the aquifer is likewise divided into upper and lower aquifers. The upper sand is fine-grained and shaley and the lower sand is coarser; therefore, most wells are completed in the lower section.



CARSWELL AIR FORCE BASE, TEXAS
AREAL EXTENT OF THE PALUXY AQUIFER, NORTH TEXAS
FIGURE 6

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Recharge to the Paluxy aquifer occurs where the formation outcrops west of Carswell AFB. The Paluxy also outcrops north of the base in the bed of Lake Worth. The lake represents a significant recharge point for the aquifer and creates a potentiometric high in its vicinity. Regional groundwater flow within the Paluxy is eastward, in the direction of the regional dip. At Carswell AFB, groundwater flow is influenced by the Lake Worth potentiometric high and by a potentiometric low created by the groundwater withdrawals of the community of White Settlement, resulting in a more southeasterly flow direction.

Transmissivities in the Paluxy aquifer range from 1,263 to 13,806 gallons per day per foot (gpd/ft) and average 3,700 gpd/ft. The Paluxy Formation thickness ranges from 140 to 190 feet and averages 160 feet in Tarrant County. The actual water-bearing thickness in the Carswell AFB area probably approximates the formation thickness, but the aquifer is separated into two distinct water-bearing zones. In the vicinity of Carswell AFB, permeabilities range from 13 to 140 gpd/ft^2 (based on an approximate thickness for the aquifer of 100 ft.) Well yields within the Paluxy aquifer range from 10 to 480 gallons per minute (gpm) and average approximately 100 gpm.

The Paluxy aquifer is an important source of potable groundwater in the Fort Worth area. Communities surrounding Carswell AFB, especially White Settlement, develop municipal water supplies from the Paluxy, as well as from the deeper Twin Mountains aquifer. As a result of its extensive use as a water supply, water levels in the Paluxy aquifer have declined significantly over the years. Water levels in the immediate Carswell AFB vicinity have not decreased as much as in the Fort Worth area in general because the base does not develop water from the Paluxy.

Water quality in the Paluxy aquifer is generally good and is satisfactory for potable use. The range of chemical constituents occurring within Paluxy water is given in Table 3.

2.3.2.4 <u>Glen Rose Aquitard</u>. Below the Paluxy Aquifer are the fine-grained limestone, shale, marl, and sandstone beds of the Glen Rose Formation. The thickness of the formation varies from 250 to 450 feet. Though the sands in the Glen Rose Formation yield small supplies to wells in Fort Worth and western Tarrant County, the relatively impermeable limestone is an aquitard restricting water movement between the Paluxy aquifer above and the Twin Mountains aquifer below.

2.3.2.5 <u>Twin Mountains Aquifer</u>. The Twin Mountains Formation is the oldest formation used for water supply in the Carswell AFB area. The formation consists of a vasal conglomerate of chert and quartz, grading upward into coarse-to fine-grained sand interbedded with shale. The thickness of the formation varies between 250 and 430 feet.

Recharge to the Twin Mountains aquifer occurs west of Carswell AFB, where the formation crops out. Water movement is eastward in the downdip direction. Like water in the Paluxy aquifer, Twin Mountains water occurs under water-table conditions in the recharge area and becomes confined as it moves downdip.

The Twin Mountains aquifer is the principal aquifer in Tarrant County. The formation yields large water supplies for municipal and industrial purposes. Transmissivities in the Twin Mountains aquifer range from 1,950 to 29,700 gpd/ft and average 8,450 gpd/ft in Tarrant County. Permeabilities range from 8 to 165 gpd/ft^2 and average 68 gpd/ft^2 in Tarrant County.

Groundwater withdrawals from the Twin Mountains aquifer, primarily for municipal water supply, have resulted in declining water levels. Between 1955 and 1976, the potentiometric surface of the aquifer dropped approximately 250

TABLE 3

RANGE OF CONSTITUENTS IN GROUNDWATER FROM SELECTED WELLS IN THE PALUXY FORMATION, TARRANT COUNTY

Constituent or Property	Symbol	Concentration*
Bicarbonate	HCO_3	177 - 689
Boron	B	0.1 - 0.6
Calcium	Ca	0 - 120
Chloride	Cl^-	5 - 117
Fluoride	F^-	0 - 4.5
Iron	Fe	0 - 9.9
Magnesium	Mg	0 - 43
Nitrate	NO_3^-	0 - 10.0
Silica	SiO_2	
Sodium	Na	11 - 740
Sulfate	SO_4^{--}	6 - 1080
Dissolved Solids		264 - 2176
Total Hardness	$CaCO_3$	2 - 401
Percent Sodium	%	7.1 - 99.5
pH		7.1 - 9.2
Sodium Absorption Ratio	SAR	0.2 - 68.8
Residual Sodium Carbonate	RSC	0 - 10.0
Specific Conductance (umhos at 25°C)		427 - 3193

* Values shown are measured in milligrams per liter (mg/l), except percent sodium, pH, SAR, RSC and specific conductance.

SOURCE: Texas Department of Water Resources, 1982.

feet. Water quality in the Twin Mountains aquifer is suitable for potable use throughout the Fort Worth area.

2.3.3 Climatology/Air. Carswell AFB is located near 33 north latitude in north central Texas. The climate is humid subtropical with hot summers and dry winters. Tropical maritime air masses control the weather during much of the year; however, the passage of polar cold fronts and continental air masses create large variations in winter temperatures. Meteorological data summarizing the period 1946 through 1978 are presented in Table 4 and discussed briefly below.

The average annual temperature for Carswell AFB is 66°F and monthly mean temperatures vary from 45°F in January to 86°F in July. The average daily minimum temperature in January is 35°F and the lowest recorded temperature is 2°F. The average daily maximum temperature in July and August is 95°F and the highest temperature recorded at the base was 111°F in the month of June. On the average, freezing temperatures occur at Carswell AFB on 33 days per year.

Mean annual precipitation recorded at Carswell AFB is 32 inches. The wettest month is May with a secondary maximum in September. The period from November to March is generally dry with a secondary minimum in August. Snowfall accounts for a small percentage of the total precipitation between November and March. On the average, measurable snowfall occurs on 2 days per year. Lake evaporation at Carswell AFB is estimated to be approximately 57 inches per year. Evapotranspiration over land areas may be greater or less than lake evaporation depending on vegetative cover type and moisture availability. Average net precipitation is expected to be equal to the difference between average total precipitation and average lake evaporation or approximately minus 25 inches per year.

TABLE 4

METEOROLOGICAL DATA SUMMARY FOR CARSWELL AFB, TEXAS

	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Temperature (°F)													
Mean	45	50	57	66	74	82	86	85	78	68	56	49	66
Average Daily Maximum	55	60	67	76	83	91	95	95	88	78	66	59	76
Average Daily Minimum	35	39	46	56	64	72	75	75	68	57	46	38	56
Highest Recorded	88	88	85	89	100	111	109	110	107	105	89	91	110
Lowest Recorded	2	6	11	31	43	55	61	60	46	33	17	11	2
Precipitation (inches)													
Mean	1.7	1.9	2.1	3.9	4.2	3.1	2.5	2.1	3.6	3.1	1.8	1.9	31.9
Maximum Monthly	5.9	4.7	6.5	14.2	15.2	8.8	9.0	6.0	9.6	10.7	7.4	6.7	15.2
Minimum Monthly	0.1	0.1	a	0.8	0.8	0.1	a	a	a	a	a	a	a
Maximum in 24 hours	2.8	3.2	3.4	3.3	5.7	3.5	5.9	3.1	4.0	3.2	2.8	2.9	5.9
Days with Thunderstorms	1	2	3	6	8	6	5	5	4	3	1	1	45
Snowfall (inches)													
Mean	2	1	6	0	0	0	0	0	0	0	b	b	3
Maximum Monthly	8	12	7	0	0	0	0	0	0	0	4	3	9
Maximum in 24 hours	5	8	7	0	0	0	0	0	0	0	4	3	8
Relative Percent Humidity (%)													
Mean	62	61	61	64	68	64	58	60	65	65	63	62	63
Surface Winds (knots)													
Mean	8	8	9	9	7	8	6	5	6	6	8	8	7
Maximum	50	63	69	64	68	65	56	54	80	45	54	58	80
Prevailing Direction	S	S	S	S	S	S	S	S	S	S	S	S	S

SOURCE: United States Air Force, Carswell AFB, Texas. Period of Record: 1946-1976

a Less than one-tenth inch

b Less than 1 inch

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Thunderstorm activity occurs at Carswell AFB an average of 45 days per year. The greatest number of these storms occurs between April and June. Hail may fall on two to three days per year, and the maximum precipitation recorded in a 24-hour period is 5.9 inches.

Mean cloud cover averages 50 percent at Carswell AFB with clear weather occurring frequently during all months. Some fog is present on an average of 83 days per year. Wind speed averages 7 knots; however, a maximum of 80 knots has been recorded. Wind direction is predominantly from the south during all months.

2.4 Human Environment.

2.4.1 **Population**. The total work force at Carswell AFB is approximately 3,500, which includes about 1,000 civilian personnel.

2.4.2 **Demographics**. The city of Fort Worth had a population of 414,562 based on a 1984 estimate. This estimate also included a population density of 1,617 people per square mile. The smaller suburbs of Fort Worth adjacent to Carswell AFB had 1980 population data as follows:

White Settlement	13,508
Westworth	3,651
River Oaks	6,890

2.4.3 **Land Use**. The base is surrounded by residential, commercial, recreational, and industrial land. Residential land use is to the southwest, southeast and east of the base. Commercial property is south and recreational (Lake Worth) is north of the base. Air Force Plant 4 is the industrial facility directly west of Carswell AFB.

2.4.4 Map Preparation. To support the reporting effort, maps will be prepared utilizing an in-house PC-based system Intergraph. This system will permit relatively fast development of report maps and map changes. The system permits the integrating and development of geologic cross sections and plane maps. Additionally, the system permits various scales to provide the optimum map size for the report. The results will be maps, figures and legends that are clear for ease of interpretation and of publishable quality.

In general, the following types of maps and figures will be developed:

- General Carswell AFB installation features and boundaries (e.g., major installation support and operational facilities).
- Site locations and plan views.
- Monitoring well/boring/sampling locations/cross sections.
- Surface drainages and water bodies.

Some of the specific types of maps and figures that will be developed include hydrogeological cross-sections, water table elevation contour maps, water well inventory locations and related data.

3.0 Site Specific Background.

The Base Service Station is located on the northwest corner of Rogner Drive and Jennings Drive. The Base Service Station has been in operation for less than 20 years, and was constructed to replace the abandoned service station located at Site SD-13, the Unnamed Stream. Surface drainage from Site BSS flows to culverts adjacent to Rogner Drive (Figure 7).

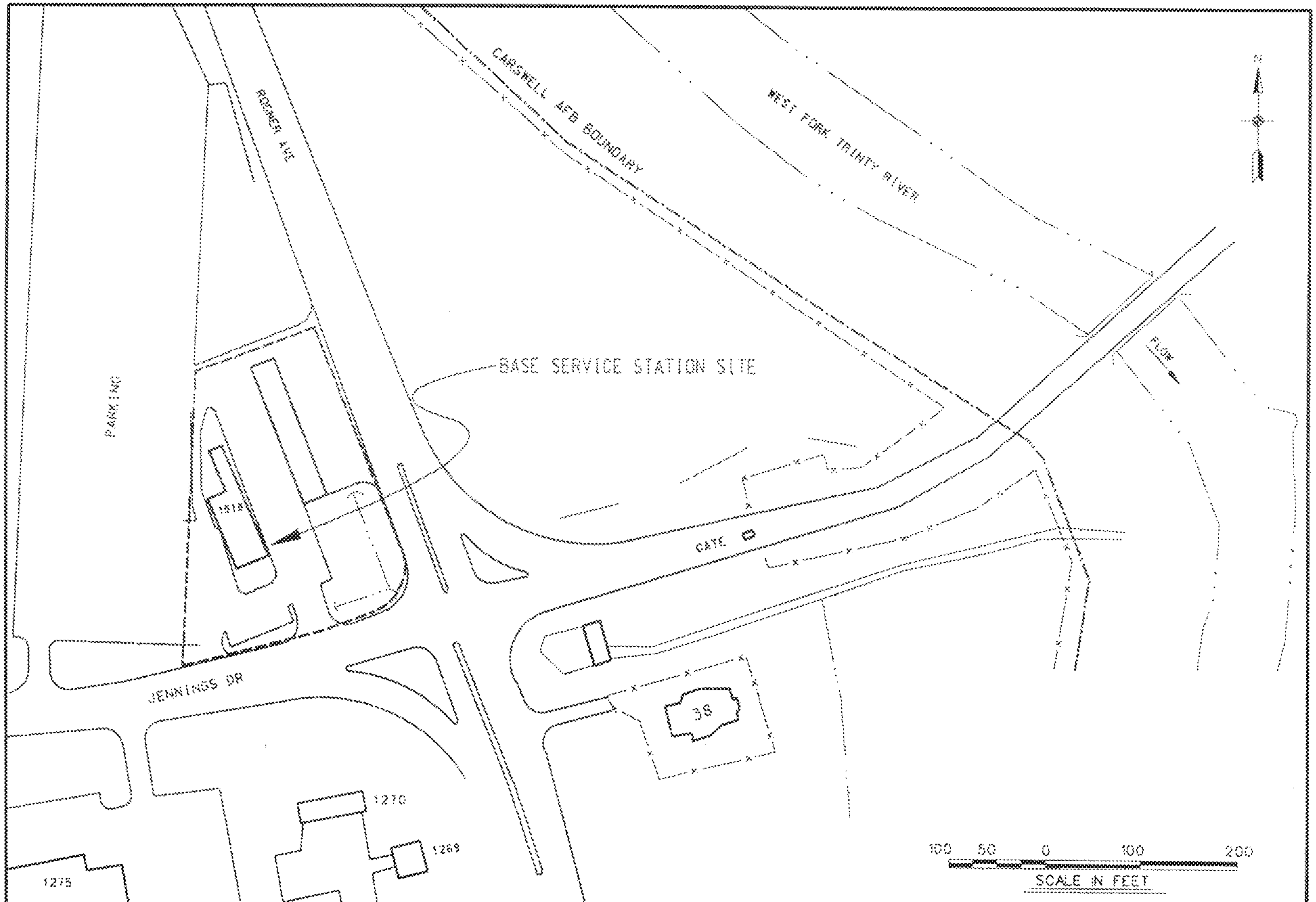
4.0 Site ST16 Specific Discussion.

It was discovered in October 1992, that gasoline was leaking from the four 10,000 gallon fiberglass reinforced plastic underground tanks located north of the pump islands. Carswell AFB was issued a Notice of Violation (NOV) for this particular site soon thereafter. In January 1993, the Fort Worth District Corps of Engineers drilled three exploratory borings in the vicinity of the Base Service pumping islands. Results of sampling from the borings showed high concentrations of petroleum hydrocarbons. Because of this, it was recommended that additional investigations be performed.

In order to determine the current conditions at the site and assess the likely environmental impact of suspected past disposal practices, it will be necessary to perform a site exploration. The following activities are recommended:

- Locate three exploratory borings to determine the potentiometric values and groundwater direction (Figure 8). The borings will also provide subsurface soil information.

- Locate a maximum of five exploratory borings to determine the potentiometric values and groundwater direction. The borings may qualify for the placement of monitoring wells. Install five wells near the site in order to assess the degree of groundwater contamination. The wells will be installed with long screens extending above the water table to intercept floating hydrocarbon product (if any). From these wells, conduct two rounds of groundwater sampling and analyze for general water quality

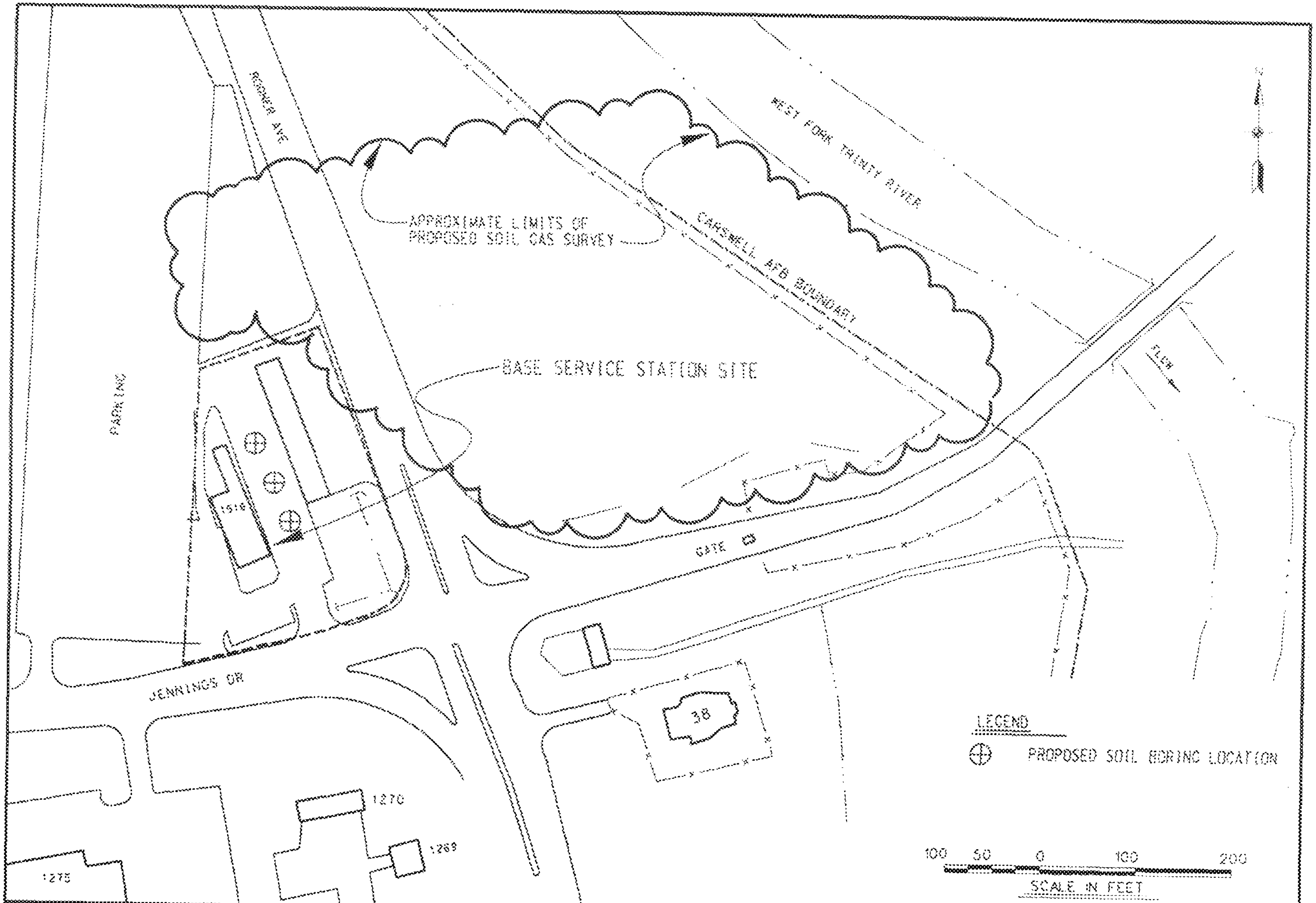


CARSWELL AIR FORCE BASE, TEXAS

SITE PLAN, BASE SERVICE STATION, ST16

FIGURE 7

120 31



CARSWELL AIR FORCE BASE, TEXAS

SITE PLAN, BASE SERVICE STATION, ST16

FIGURE 8

parameters, petroleum hydrocarbons, metals and purgeable organic compounds.

- Perform a soil/gas survey on approximately 97 points in the area downgradient from the service station.

GROUNDWATER TESTING PARAMETERS

Volatile Organics	EPA Method 8240
Metals	
Arsenic	EPA Method 7060
Barium	EPA Method 6010
Cadmium	EPA Method 6010
Chromium	EPA Method 6010
Lead	EPA Method 6010
Mercury	EPA Method 7471
Nickel	EPA Method 6010
Selenium	EPA Method 7740
Silver	EPA Method 6010
Zinc	EPA Method 6010
Total Petroleum Hydrocarbons	EPA Method 418.1

5.0 Hydrogeologic Assessment.

The purpose of the hydrogeologic assesement is to develop a complete understanding of the groundwater system on-and off-base by integrating the available data from earlier investigations and by conducting additional field studies to fill data gaps or provide additional detail where necessary. Specific purposes of this evaluation include: developing a better understanding of on-and off-base ground water flow; relationships between saturated zones; extent and migration of contamination plumes; seasonal changes in water levels and flow. Results of this study will form the framework of the evaluation of groundwater impacts, qualitative risk assessment, and remedial action alternatives. The information developed in the detailed site characterization of individual contamination areas will form an integral part of the data used in this task.

The hydrogeologic assessment will draw on the results of all previous groundwater investigations conducted at Carswell AFB. In addition to those sources, previous studies will now be updated with any regional and area studies by federal, state, and local agencies and other published and unpublished information will be used.

5.1 Subsurface Soil Surveys. Up to 5 additional boreholes will be drilled for this investigation. The boreholes at the site are to provide geologic and chemical data of the subsurface to detect and define lateral or vertical extent of contamination at a site. As many as three qualified boreholes will be converted to monitoring wells.

Soil samples from boreholes will be obtained using ASTM Method D-1586. The samples will be collected at 2.0-foot intervals for to the total depth drilled. The total depth of each borehole is expected to range between 20 and 25 feet when bedrock is reached. Samples description shall be as per ASTM 2487-85 and evaluated by a geotechnical engineer or geologist. Details of the quality control, handling and screening procedures are provided in the Quality Assurance Project Plan found in Appendix B.

Air monitoring during all well drilling and soil boring work will be accomplished with an organic vapor analyzer utilizing a photoionization detector (PID) or flame ionization detector (FID) to identify the presence of potentially hazardous and/or toxic vapors or gases. The air monitoring results will be noted in the boring logs. If soil encountered during borehole drilling is suspected to be hazardous because of abnormal discoloration, odor or air monitoring levels, the drill soil cuttings will be containerized in new, unused drums. A different drum will be used for each boring where soil encountered is suspected to be hazardous. The field log will reflect the boring logs depth(s) from which the suspected contaminated soil cuttings were collected. Composite drill cutting samples will be obtained for chemical analysis in accordance with the EPA publication SW-846, per Table B-1 of Appendix B.

The discrete soil and formation samples will be screened using either the organic vapor analyzer described above and/or Draeger tubes in order to detect the presence of volatile organic contaminants. Selected samples will be placed into a clean glass jar for detailed contaminant screening. The volatile organic levels will be recorded on the field log. These field analyzes, although calibrated, will be useful only as indicators of the presence of significant contaminant levels. Because the instruments are sensitive to moisture and fluctuating environmental conditions at the site, small concentrations above background listed on the field logs would be considered insignificant. The organic vapor concentrations which may be detected in disturbed soil samples represent an indication of the presence of gross contamination only, and in no way are intended to represent the actual levels of contaminants present in the formations. Spacing, depth, and location of the borings will be as shown on the plans.

5.2 Monitoring Wells. The objective of the investigation at Carswell AFB is to define the presence, magnitude, direction, rate and extent of movement of any identified contaminants. To accomplish this task, four monitoring wells and one background will be installed.

5.2.1 Drilling Methods. The field team will use a hollow-stem auger rig to drill the upper zone monitoring wells. This method performs well in unconsolidated sediments, allows the rig to operate without the use of drilling fluids, and permits ease of collection for formation samples. The hollow-stem auger can be used as a temporary casing to prevent the borehole from caving during drilling and completion of test wells. For the depths and geology involved, this drilling method will provide fast, efficient performance at a relatively low operating cost.

Each new monitoring well will be developed as soon as practical after completion. The monitoring wells will be developed by a submersible pump, and/or bailer. Monitoring well development will continue until the discharge water is clear and free of sediment to the fullest extent possible. All water during development will be collected and disposed of through an existing oil/water separator connected to a base sanitary sewer. The development water production (rates), pH, specific conductances and water temperature will be measured. These data will be included in the final report.

5.2.2 Construction of Wells. Following the completion of drilling operations, each well will be screened above and below the water table surface with a minimum of 10 feet and maximum of 35 feet of screen. The screen will consist of 4-inch diameter PVC casing with up to 0.010-inch slots. The material lengths selected will be based upon site specific ground water conditions encountered. The screen will be capped at the bottom. All connections will be flush jointed and threaded.

The screened section will be joined to a 4-inch diameter, Schedule 40 PVC, flush threaded casing. The casing will extend from the top of the screen to at least ground surface. To ensure the chemical integrity of the test wells, no glues, solvents, or thread compound will be employed during screen and casing installations. Prior to installation, the casing and screen sections will be thoroughly washed using a high-temperature, high-pressure sprayer, with Base potable water.

5.2.3 Monitoring Well Development. After the casing and screen have been installed for each well, a sand or gravel pack will be emplaced between the screen and the boring wall. The pack will consist of washed and bagged rounded sand or gravel with a grain size distribution compatible with the screen and the formation. The pack will be emplaced from the bottom of the borehole to 2 feet above the top of the screen. The auger flights will be used as the tremie pipe.

Granulated or pelletized bentonite will be placed (in the well and measure it with a weighted tape) above the sand/gravel pack to a minimum thickness of 2 feet to provide an adequate seal. The bentonite seal will be wetted in the hole using 1-2 gallons of Base potable water to ensure that the seal is developed before cementing operations begin.

Neat cement (Type I Portland cement) grout will be emplaced from above the top of the bentonite seal to land surface. No more than an eight percent gel mixture may be used. For water table conditions, grout will be emplaced through the augers and then the auger string withdrawn. If artesian conditions exist, a small diameter tremie pipe will be used to emplace the grout.

5.2.4 Surface Completions of Monitoring Wells. Two methods for the well surface completions will be employed at Carswell AFB depending on input from base officials. If well stick-up is of concern in an area, the well will be completed flush with the land surface. In the case of flush completion, the PVC casing will be cut 2 to 3 inches below land surface, and a watertight protective manhole with a locking cap will be installed. A locking system will be provided to discourage any tampering.

When above-ground surface completion is used, the PVC well casing will be extended about 2 or 3 feet above land surface. An end plug or casing cap will be provided for each well. The extended PVC casing will be shielded with at least a 4-inch diameter steel guard pipe. The guard pipe will be placed over the PVC casing and cap and will be seated in a 24-inch by 24-inch by 4-inch concrete surface pad. The protective casing will be installed with a lockable cap or lid to discourage vandalism.

In the case of an above-ground completion, three 3-inch diameter steel guard posts, will be installed radially from each wellhead. The guard posts will be placed approximately 2 to 3 feet into the ground and extend 5 feet above the ground surface. At some sites, the guard posts may be removable to facilitate access for sampling activities. In these cases, a locking mechanism will be provided to prevent unauthorized removal.

5.2.5 Surveying of Monitoring Wells and Boreholes. All monitoring wells and boreholes will be surveyed for elevations and locations. A registered professional land surveyor will be retained to survey the vertical elevations of the wells and the tops of the boreholes. This survey will have an accuracy for vertical elevations of ±0.01 foot for all monitoring wells and ±0.1 foot for boreholes. Horizontal locations will be accurate to ±1 foot. All surveying will use an established U.S.C. & G.S. or U.S.G.S. benchmark as point of origin. All surveyed points and benchmarks used will be recorded on site maps.

5.2.6 Aquifer Tests. Slug tests will be conducted on three selected monitoring wells after the completion of groundwater sampling. The slug test provides an indication of aquifer characteristics such as hydraulic conductivity. Also, this test is ideally suited for low-producing formations that cannot be pumped. Monitoring wells will be selected with the hydrogeologic characteristics that will optimize slug testing. The resulting data will be used in conjunction with the groundwater geologic data. The slug test equipment will be decontaminated to prevent any well contamination.

5.3 Groundwater Samples.

5.3.1 Groundwater Level Measurements. Following completion and development of the monitoring wells, but prior to sampling activities at each site, a round of water level measurements will be conducted on the monitoring wells. Water levels will be measured to the nearest 0.01 foot from the top of the marked casing using an electric line water level indicator. When the electrode of the water level meter comes in contact with the water, a meter reacts or a tone sounds. Additionally, the surface of the water will be examined for the presence of hydrocarbons. If hydrocarbons are present, the thickness of the layer will be measured and recorded.

5.3.2 On-Site Field Analyses. Each monitoring well will be purged immediately prior to sample collection to ensure that fresh formation water is collected. Purging will occur at least three days after completion of monitoring well development. When possible, sampling will begin at upgradient monitoring wells and/or low contamination areas then move to downgradient and/or higher contamination areas.

Purging operations will be conducted using a submersible pump or a bailer. Purging operations will be considered complete when three wetted well casing volumes have been removed or when the pH (±0.1 unit), temperature (±0.5°C), specific conductance (±10 micromhos), color and odor of the discharge are stabilized. After purging the wells, groundwater samples will be collected from the discharge line of the submersible pump or with a Teflon bailer or 2-inch stainless steel Kemerer sampler. This latter sampler can provide non-aerated groundwater samples at discrete depths which aids in ensuring the integrity of any volatiles in the groundwater.

The methods for obtaining the water data are as follows. All downhole equipment used during the purging of the monitoring wells will be carefully washed to prevent cross-contamination. Details of the decontamination process are provided in the Quality Assurance Project Plan (QAPP) in Appendix B. As an additional step to prevent cross-contamination of the wells, purging/sampling operations will progress from areas suspected to contain little or no contamination to areas assumed to have higher contamination levels. The purged groundwater will be disposed through an oil/water separator connected to a sanitary sewer.

5.3.3 Temperature and pH. Measurements of the sample temperature will be taken using a mercury thermometer. The field measurement represents the temperature of the groundwater at a particular location and time. The pH of each sample will be measured by a Myron L pDS (Model EP11/pH) meter or equivalent. The pH of the sample will be measured as quickly as possible after collection.

5.3.4 Specific Conductivity. The specific conductivity of each sample will be measured with a Myron L pDS meter (Model EP11/pH) or equivalent. Elevated specific conductivities indicate the presence of conductive ions in the groundwater.

5.3.5 Sampling for Laboratory Analysis. Water samples collected from the wells will be placed in laboratory prepared containers, preserved as appropriate, chilled to 4°C and shipped to the Southwestern Division

Laboratory. The groundwater samples and type of analysis will be summarized per Table B-2 of Appendix B. Also, the table will show data for surface water sampling. Chain of custody documents will accompany all samples. Analytical methods, preservations and holding times are provided in detail in the QAPP (included in Appendix B).

5.3.6 Split Sample Procedures. When split samples are required, the sample will be divided such that all the containers have a representative portion. In the case of solid samples (soil and formation), samples will be split longitudinally when possible and any loose material will be divided as equally as possible among the containers. Samples for volatile contaminants will be placed directly into the sample container with minimal disturbance. Water samples will be split by pouring an equal volume of liquid among the containers for each collection. The containers will then be labeled on-site and the samples recorded in a log book.

5.3.7 Drum Sampling. During the borehole and monitoring well drilling activities, cuttings that are suspected of being hazardous because of abnormal discoloration, odor or air monitoring levels will be containerized as discussed previously in Subsection 5.1, Subsurface Soil Surveys. To determine the final disposition of the cuttings in the drums, a composite sample will be obtained from each drum identified using a stainless steel scoop. Up to two composite samples will be collected for chemical analysis. Each composite sample of the drill cuttings will be analyzed for TCLP concentrations of metals, pesticides, herbicides, volatiles and semivolatiles to determine if the soil cuttings must be disposed of as a hazardous waste.

5.3.8 Evaluation-Related Tasks. The objectives of the data evaluation process are to summarize the existing information on the hazardous waste sources, pathways, receptors, and to evaluate potential impacts on the base and public health, and the environment. Site specific analytical data resulting from the field investigation at the Base as well as regional information are considered in the evaluation process.

5.3.9 Data Management. The field investigation will generate large amounts of data on the hydrogeology and chemistry about the study sites. A computerized data system will be used to convert the raw field data and analytical data into a usable form for reporting. Therefore, the computerized data system will be designed to support the following activities.

- Archive, analyze and manipulate physical, chemical, biological and geological data collected.

- Analyze data with respect to trends or violations of environmental protection guidelines.

- Produce subsets of data to form summary reports and data files which can be analyzed by environmental models and statistical algorithms.

- Interpret relationships between contaminant migration and biogeochemical relationships existing at a particular site.

5.3.10 Schedule for Collecting Samples. Wells shall be monitored during 3 months. Sampling event spaced at 2 month intervals and analyzed in accordance with USEPA SW-846.

5.4 Reports.

5.4.1 Preliminary Soils and Groundwater Report. The report shall contain a site map (scale: 1" = 50 ft) and it will depict Site ST-16, existing and proposed borings, monitoring wells and geologic cross sections. Plans and schedule for submitting the hydrologic information and well construction.

5.4.2 Preparation of Final Report. Carswell Air Force Base will prepare RI/FS final report. The report will be submitted in four copies. The following items will be included:

a. Contours of the groundwater surface based on measurements in piezometers, monitoring wells and apparent direction of ground water flow.

b. The geologic cross-section depicting the near-surface stratigraphy.

c. Logs of all soil borings, monitoring wells, results of analyses for soil and ground water.

d. Contours of groundwater contamination and definition of plume.

6.0 Certification for Wastes and Submittals.

The assessment of the site will be based on the value of the data collected. The physical, chemical data and field observations will be the foundation for making the interpretation about the site. The option of no wastes will be exercised if analyses indicate so.

7.0 Time Schedule.

Carswell AFB requests authorization to proceed with the remedial investigation upon approval of this work plan. A detailed schedule of work will be prepared prior to commencement of field activities.

130 41

ILLEGIBLE DOCUMENT

THE FOLLOWING DOCUMENT(S) IS ILLEGIBLE OR OF POOR LEGIBILITY IN THE ORIGINAL THIS IS THE BEST COPY AVAILABLE.

130 42

U.S. ARMY CORPS OF ENGINEERS
SOUTHWESTERN DIVISION LABORATORY

Sampling and Analyses
Quality Assurance/Quality Control Plan

March 1993

I. Purpose:

The purpose of this QA/QC plan is to describe the quality assurance and quality control procedures followed by the Southwestern Division Laboratory and their contractors when performing analyses of samples from their clients. These procedures are used to ensure that the generation, processing, verification and reporting of the data by the laboratories are reliable, accurate and properly documented.

II. References:

The following references were used in the preparation of this plan:

A. U.S. Environmental Protection Agency, Test Methods for Evaluating Solid Wastes, SW 846, November 1986.

B. American Public Health Association and American Waterworks Association, Standard Methods for the Examination of Water and Wastewater, 16th ed., 1985.

C. U.S. Environmental Protection Agency, Methods for Chemical Analysis of Water and Wastes, EPA - 600/4-79-020, 1979.

D. U.S. Environmental Protection Agency, Handbook for Sample Preparation of Water and Wastewater, EPA - 600/14-82-029, 1982.

E. U.S. Environmental Protection Agency/Corps of Engineers, Procedures for Handling and Chemical Analysis of Sediment and Water Samples, EPA/CE-81-1, 1981.

F. U.S. Army Corps of Engineers, Chemical Data Quality Management for Hazardous Waste Remedial Activities, ER 1110-1-263, March 1990.

G. Forester and Mason, Journal of Forensic Chemistry, Vol. 19, #1, pages 155 to 162, 1974.

III. Sample Collection:

A. Well Sampling:

All groundwater samples shall be taken using a stainless steel or teflon bailer. Each sample container shall be filled directly from the spout or discharge tube. Samples shall be placed in appropriate containers as detailed in Table B-1 of Appendix B of the Quality Assurance Project Plan (QAPP). Labels must be affixed to each container with the following information written with permanent ink: well identification, date, required analysis, methods of preservation, sampler's identification.

B. Soil Sampling:

Soil samples shall be taken by augering with a drill rig. Samples shall be collected in glass liter or half-liter wide-mouthed jars with teflon lined caps. Labels must be affixed to each container with the following information written with permanent ink: well or boring identification, depth, date, required analysis, sampler's identification.

C. Sediment Sampling:

Bottom Sediment samples shall be taken using a core or grab sampler, depending on which method provides the most representative sample of the site. Samples will be collected either with a glass or stainless steel sampler, mixed in the field and placed in glass liter or half-liter wide-mouthed jars with teflon lined caps. Labels must be affixed to each container with the following information written with permanent ink: location identification, date, depth, required analysis, sampler's identification.

IV. Cleaning Sampling Equipment:

Water samplers used for collecting inorganic samples may be cleaned with non-phosphate detergent followed by rinses with tap water, dilute hydrochloric acid and distilled water. Water samplers used for collecting organic samples shall be cleaned with non-phosphate detergent followed by rinses with tap water, distilled water, pesticide grade hexane and pesticide grade methanol. The last two rinses should be done under a hood or well ventilated conditions. Drilling rigs and core samplers used for soil and sediment sampling shall be steam cleaned after each sampling or boring.

V. Sample Preparation and Preservation:

A. Preservatives:

Preservatives are listed in Table B-1, Appendix B of the QAPP. All chemical preservatives shall be of reagent grade quality. Preservatives shall be added dropwise from dedicated containers in order to achieve proper pH or concentration at the sampling site. A calibrated pH meter shall be used to check pHs.

B. Refrigeration:

Keep all samples refrigerated or iced down in coolers if space permits; otherwise, refrigerate those samples needing refrigeration as indicated in Table B-1.

VI. QA Samples:

There shall be a minimum of one QA field split or duplicate sample taken for every ten samples of each matrix type collected. There shall also be a minimum of one blank sample for each matrix type for every ten samples. Field blanks may consist of clean or background soil samples, water from background wells, sample rinsates, or distilled water as appropriate to the sample type.

VII. Documentation:

A. Fieldbook:

A field book shall be kept of all operations and contain the following: well or boring number, date, water level, well evacuation procedure and rate of recharge, sample method, pH and conductivity readings, any unusual conditions noted (odor, color, well damage, etc.) times of collection, preservation and shipment, sampler's name and any information regarding blank samples.

B. Field Data Form:

The field data form includes selected information from the fieldbook relevant to the analyses of the sample; such as, pH, conductivity, unusual odor or color, water level, etc. This form shall be shipped in the cooler.

C. Chain of Custody Form:

The chain of custody form is required to establish possession of the samples from collection to analyses. This form shall be shipped in the cooler with the samples and must be signed by both the sample collector and the sample preparer.

VIII. <u>Shipment:</u>

Samples shall be placed in coolers equipped with inserts to hold containers securely. Samples shall be covered with ice and have accompanying documentation sealed in plastic bags inside the coolers. Coolers shall be sealed with straps or tape and have a minimum of two chain of custody seals placed across the opening. Coolers may be shipped by commercial or government carrier and must be received by SWD Laboratory within 24 hours of the time the samples were collected.

IX. <u>Sample Custody:</u>

A. Sample Receiving and Chain-of-Custody Procedures are designed to track the movement of samples from the time they leave the sampling site to the time they are analyzed.

1. All samples are received in a designated area of SWD Laboratory by a sample custodian. Each sample is thoroughly examined to ensure that proper sampling, preservation, packaging and labeling techniques have been employed.

2. Each sample is assigned a unique SWD Laboratory sample number and recorded in a bound log book which includes lab and field sample numbers, date sampled, date arrived to SWD, Corps of Engineers District or client generating sample, location of sampled area, sample description, and list of analyses requested. This information is also maintained on computer files.

3. The Chain-of-Custody is checked for accuracy and signed and dated. Any significant information concerning samples is recorded on the Chain-of-Custody at this time.

B. <u>Sample Storage:</u>

1. Samples are stored at 4°C -- checked and recorded daily -- in six 3' X 6' X 6' stainless steel refrigerators.

2. Samples are stored for a minimum of six weeks after data has been submitted to client.

3. Volatile samples are stored separately in two, 21 cu. ft. refrigerators.

C. <u>Contract Laboratories:</u>

1. Samples which are to be transferred to a contract laboratory are shipped within twenty-four hours of receipt by SWD Laboratory.

2. Samples are shipped in coolers with form-fitting inserts and covered with ice. Coolers are secured with straps and chain-of-custody seals then shipped for next day delivery by commercial carrier.

3. Sample shipment includes samples, chain-of-custody documentation with explicit instructions concerning sample identification, required analyses, turnaround date and sample collection date.

D. <u>Requirements of Contract Laboratories:</u>

1. Contractor must be validated by the Corps of Engineers Missouri River Division Laboratory.

2. Contractor must have minimum duplicity of all major analytical equipment.

3. Contractor must be certified by the Oklahoma Water Resources Board.

X. Reporting and Recording Data: Analytical data is reported and recorded in the following manner:

A. All raw data is recorded in bound books and/or computer printout.

B. Written reports are submitted to the client after a project is completed or at regular intervals for long-time projects. Each report contains the following information:

1. Identification of samples by the field number and by the SWD number.

2. Minimum detection limits for each constituent reported.

3. Quality control and quality assurance data such as method blanks, surrogate recoveries, duplicates and spikes applicable to the data set.

4. Analytical results.

5. Data Analyzed.

6. Date sample collected and date received by SWD.

7. Method of Analyses.

C. Data and information concerning analyses is available by telephone, computer interface or modem or computer disc.

D. Laboratory Director maintains records of all reports submitted to clients.

E. Environmental Services Section maintains records of all raw data, hard copy of all reports and computer records of all analytical and quality control data.

XI. Preventative Maintenance: In order to prevent instrument down time and costly instrument repairs, SWD uses the following methods of maintenance:

A. Service maintenance contracts are purchased for all major equipment such as both Perkin Elmer Atomic Absorption Spectrophotometers, the ARL ICAP, the Hewlett-Packard GC/MSD, the Hewlett-Packard GC, the Dohrmann TOX Analyzer, the Waters IC/HPLC and the O.I. TOC Analyzer.

B. Specific operator manuals are used to outline preventative maintenance plans for all equipment.

C. Each instrument has an instrument log book in which the daily performance, preventative maintenance activity, problems, etc. are recorded.

XII. Data Validation: Data validation is accomplished by monitoring the precision and accuracy of quality control data, system audits and by utilizing known and blind standards.

A. Initial Calibration: At the beginning of each day, each instrument is calibrated by standard samples according to the prescribed method. This calibration is verified by an analysis of method blank samples immediately after the calibration procedure and immediately before sample analyses.

1. Standards are either bought or prepared using certified chemicals as specified in the methods.

2. Data from standards are accumulated starting from the lowest concentration and ending with the highest.

3. Calibration is verified by an EPA Quality Control Sample at the rate of at least 10%. Calibration curves are generated using at least three data points.

4. Calibration data is recorded on raw data sheets kept in bound books and/or computer files.

5. Method blanks are prepared for every twenty samples or less containing appropriate amounts of reagents used in sample preparation. Data from the blank is determined and recorded after calibration. If the method blank is above the required detection limit and/or the lowest analyte is less than ten times the blank concentration, the entire sample set will be reanalyzed.

B. Spiked Sample Analyses: Spiked samples are samples altered by the addition of known amounts of analytes. These samples are analyzed along with actual samples. The percentage of analyte recovery is then calculated to ascertain quality of data.

1. Spiked samples are prepared before sample preparation procedures (digestion, extraction, etc.) and generated at the rate of at least 10% of samples.

2. Individual percent recoveries are calculated as follows:

$$\text{Recovery} = \frac{(SSR - SR) \times 100}{SA}$$

where SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added

3. Percent recoveries outside the range of 80% to 120% are considered outliers. Spike recoveries are disregarded for samples in which the concentration is four or more times the spike amount.

C. Duplicate Sample Analyses: A second spiked sample is prepared and analyzed as above. The information generated is used as a check on instrument reliability, operator error, chemical problems, etc.

1. The relative percent difference between the spike sample and the spike sample duplicate is calculated as follows:

$$RPD = \frac{(D1 - D2) \times 100}{(D1 + D2)/2}$$

where RPD = Relative Percent Difference
D1 = First Spiked Sample Value
D2 = Second Spiked Sample Value

2. Results of duplicate analyses for samples with concentrations greater than five times the required detection limit shall have RPD of less than twenty percent to be acceptable.

D. Correction Action: If some, but not all, spiked and/or duplicate spiked samples are found to be outliers, the entire sample set is reanalyzed using the sample extract or digestrate. If all the spikes and/or duplicate spiked samples are outliers, the entire sample set shall be reanalyzed starting from the initial step (digestion, extraction, etc.). A thorough investigation of reagents, instrument condition and calibration, and any other factors contributing to the problem of accuracy and precision will be conducted in order to correct any problems.

E. External Quality Assurance Program: SWD Laboratory participates in a QA program provided by the U.S. EPA Environmental Monitoring and Support Laboratory of Cincinnati, Ohio, the certification program by the Oklahoma Water Resource Board, and the U.S. Army Corps of Engineers validation program.

XIII. Procedure for Cleaning Glassware:

A. Trace Metals Analyses:

1. Prior to use, glassware for trace metals analyses is rinsed with pesticide grade hexane.

2. After use, glassware is rinsed with tap water, washed with a Liqui-Nox solution, rinsed twice with tap water, and finally, rinsed with distilled or deionized water.

3. Stained glassware is cleaned with a strong acid solution, then washed and rinsed as above.

B. Organic Analyses:

1. Prior to use, glassware or organic analyses is rinsed with pesticide grade hexane.

2. After use, glassware is rinsed with tap water, then sonicated for fifteen minutes in a solution of Liqui-Nox in a sonication bath. This is followed with a tap water rinse, two distilled water rinses, and an acetone rinse. After glassware is dry, it is placed in the muffle furnace at 550° C for four hours.

3. Stained glassware is cleaned with a strong acid solution after sonication, then washed and rinsed as above.

C. Other:

1. Glassware used for phosphate determination is not washed with detergents containing phosphates.

2. Glassware used for ammonia, Kjeldahl nitrogen and nitrate/nitrite is rinsed with ammonia free water.

XIV. Sample Disposal:

A. Samples are stored for a minimum of six weeks after the report is generated. The date a report is issued is put into both the sample log book and the work order book. The sample storage area for completed samples is separate from current samples and inventoried at regular intervals.

B. Hazardous samples are either returned to the client when completed or combined in specially marked containers for proper hazardous disposal.

XV. Safety:

A. Emergency Equipment:

1. The laboratory is equipped with four overhead showers, two eye washers and four fire extinguishers.

2. A Red Cross first aid kit is located on the premises.

3. All safety equipment is checked on a regular basis.

B. Protective Equipment:

1. All personnel are provided with laboratory coats, disposable aprons, gloves, respirators and protective eyewear.

2. All personnel are given a medical examination annually.

C. Ventilation:

1. The laboratory has four ventilation hoods and they are used whenever toxic or flammable materials are used.

XVI. Personnel: At the present time the laboratory is staffed by four chemists and three technicians.

Personnel currently on staff and their responsibilities are as follows:

Anhmai P. Tran, Chief, Environmental Services Section

- Provide work assignments and coordinate projects within the Chemistry section
- Maintain and upgrade QA/QC program
- Train personnel
- Purchase equipment, supplies, and materials necessary for maintaining the laboratory
- Consult with engineers, geologists and field personnel
- Evaluate and contract outside laboratories for overflow work
- Evaluate laboratory data and write reports
- Prepare Final QA/QC Reports for major projects
- Contract Officer Representative for major chemical services contracts

Dale Norwood, Chemist

- Chemical analysis using gas chromatography
- Chemical analysis using atomic absorption spectroscopy including Zeeman graphite furnace, TOC analyzer
- Chemical analysis by Supercritical Fluid Extraction and Infrared spectroscopy
- Train personnel

Christin Pruett, Chemist

- Chemical analysis by HPLC for anions and upcoming explosives
- Chemical analysis by Infrared spectroscopy for TRPH
- Chemical analysis by Gas Chromatography for pesticides and PCBs
- QA/QC Data review/evaluation

Frank Roepke, Chemist

- Chemical analysis by atomic absorption spectroscopy using Zeeman and NonZeeman graphite furnaces
- Sample prep and digestion for trace metal analysis using microwave techniques
- Sample receiving and tracking
- Chemical analysis by wet methods

Albert Acosta, Lead Technician

- Computer operations and data management
- Samples preparation and analyses for trace metals
- Chemical analyses using wet methods
- ICP analyses

Shirley Johns, Technician

- Sample receiving and tracking manager
- Sample preparation for organics
- Chemical analyses using wet methods

Randall Smith, Technician

- Sample preparation and analysis for metals
- Sample receiving and tracking
- Chemical analyses using wet methods

Resume of Anhmai Tran

2020 Via Bellena
Carrollton, Texas 75006

Work Experience:

April 1989 to present
SWD Laboratory, U.S. Army Corps of Engineers
4815 Cass Street, Dallas, Texas 75235
Position: Chief, Environmental Services Section
Duties include: Provide work assignments and coordinate projects within the Chemistry section, maintain and upgrade QA/QC program, train personnel, purchase equipment, supplies, and materials necessary for maintaining the laboratory, consult with engineers, geologists and field personnel, evaluate and contract outside laboratories for overflow work, evaluate laboratory data and write reports, prepare Final QA/QC Reports for major projects, Contract Officer Representative for major chemical services contracts.

1988 to April 1989:
Hydrocontrol Corporation
4574 Claire Chennault, Dallas, Texas 75248
Position: Chemist
Duties included: Testing and analyzing water samples. Preparing, testing and standardizing chemical solutions for customers.

1987 to 1988:
Baylor College of Dentistry
3302 Gaston Avenue, Dallas, Texas 75246
Position: Research Technician
Duties included: Prepare chemical reagents, set up laboratory instruments, photograph research pictures.

1981 to 1986:
Hydrocontrol Corporation
3801 South Moulton, Oklahoma City, Oklahoma 73158
Position: Chemist
Duties included: Research and development, test and analyze water samples. Prepare, test and standardize chemical solutions for customers.

1980 to 1981:
Oklahoma State Department of Health
1000 N.E. 10th, Oklahoma City, Oklahoma 73123
Position: Assistant Chemist
Duties included: Wet and instrumental analyses of water samples.

Related Training:

Computer Courses:
- Lotus 1-2-3, May 1989
- dBase III, June 1989

Dohrmann TOX Training, October 1989
Hewlett-Packard GC Training, November 1989
Hewlett-Packard GC/MS Training, March 1990
Waters IC/HPLC Training, May 1990

Education:

Oklahoma University
Norman, Oklahoma
Degree: Bachelor of Science, December 1979
Major: Chemistry
Minor: Physics

Saigon University
Saigon, Viet Nam
Degree: Bachelor of Science, April 1975
Major: Biochemistry

Resume of Clyde Dale Norwood

357 Forest Hill Circle
Grand Prairie, Texas 75051

Position: Analytical Chemist

Major Qualifications: Experience in analytical testing utilizing AA, ICP, GC, [illegible] p and other analytical equipment. Perform testing for heavy metals, BTEX, Pesticides, PCBs, Halogenated and Aromatic Volatile Organics.

Education: B.S. Chemistry, The University of Texas at Arlington, 1976. Undergraduate GPA: 3.4. Minor in Mathematics.

Experience:

November 1992 - present. USACE SWDED-GL. Perform Pesticide and PCB analysis of various matrixes for DERP, FUDS, IRP and other federal environmental remediation programs. Perform quality control and quality assurance in accordance with EPA and Corps protocols.

February 19[illegible] - [illegible] 1992 [illegible] [illegible] gained in the use of ICP, AA, Cold Vapor, GC - PID, GC - FID, GC - ECD, and various wet chemistry analyses of wastewater.

November 1985 - May 1987. Dresser Industries. Functioned as a QC Chemist performing metal analysis of welding rods by AA methods. Lubricant analysis by IR. Monitored plant discharges to ensure compliance with the City of Dallas Waste permit.

[illegible] Laboratory [illegible] for patients.

References: Technical and supervisory references furnished upon request.

Resume of Frank W. Roepke

601 Priscilla Lane
DeSoto TX, 75115

Work Experience

January 1992 to present:
US Army Corps of Engineers, Southwestern Division Laboratory
4815 Cass Street, Dallas, Texas 75235
Position: Chemist
Supervisor: Mai Tran
(214)905-9130
Duties include: Performing professional analytical and physical testing of water, soil and sludge material received by the laboratory for metals by accepted EPA methods. Techniques used include Atomic Absorption, colorimetric, volumetric, gravimetric and wet analysis. Duties also include tracking of samples, quality assurance of data, and initiation of reports.

1987 to 1991:
Department of Chemistry, Colorado State University
Fort Collins, Colorado 80523
Position: Research Assistant
Supervisor: Dr. Louis S. Hegedus
(303)491-6006
Duties included: Conducted research into the synthesis and reactivity of organochromium compounds. Research included assistance with X-ray crystallographic structural determination, proficiency with high field NMR, gas chromatography, and FTIR.

Related Training

DA Internship, 1991 to present
Hazardous Material Course, August 1991
Wordperfect Training, 1991

Education

Colorado State University
Fort Collins, Colorado 80523
Degree: Masters of Science (expected 1993)
Major: Chemistry - emphasis on organometallic
Thesis: Reactions of Triply-bonded Organic Substrates with Chromium Carbene Complexes

Carleton College
Northfield, Minnesota 55057
Degree: Bachelors of Arts, 1984
Major: Chemistry
Minor: East Asian Studies

Resume of Albert Acosta

3633 Big Horn Trail
Plano, Texas 75075

Work Experience:

April 1989 to present:
U.S. Army Corps of Engineers, SWD Laboratory
4815 Cass Street, Dallas, Texas 75235
Position: Chemistry Technician

September 1988 to September 1989:
Brookhaven Community College
Farmers Branch, Texas
Position: Physics Teaching Assistant

Education:

Brookhaven Community College
Degree: Associate of Science, May 1992
Major: Chemistry

Related Training:

ARL ICP Training, December 1990

XVII. Personnel Training:

A. Full time employees receive periodic outside training in environmental analyses, sampling, hazardous waste management and computer operations.

B. Students and part time employees receive on-the-job training based on needs described in job description, observe slide presentations and films describing use and operation of major equipment, and must demonstrate proficiency before being allowed to analyze samples.

C. New employees are hired for a one year probationary period. During that time the employee's work is constantly reviewed and evaluated for performance and productivity.

D. All employees' performance is reviewed annually.

XVIII. Laboratory Validations and Certifications:

A. The Southwestern Division Laboratory is validated on a annual basis by the Missouri River Division Chemical Review Section to do analyses for metals, pesticides and PCB's under the Corps of Engineers' Hazardous and Toxic Waste Program. Within a year, validation to perform petroleum hydrocarbon, purgeable volatile organics, and explosive analyses should be completed.

B. SWD Laboratory is certified bi-annually by the Oklahoma Water Resources Board and annually by the State of Arkansas Water Commission to do a wide variety of chemical analyses for projects which are under their regulatory control.

C. EPA audit samples are analyzed bi-annually by SWD Laboratory as part of the interlaboratory QA/QC program.

XIX. Equipment:

A. Instrumentation:

Item	Manufacturer	Model	Age (years)
pH Meter	Cole-Parmer	5986-60	4
Specific Ion Analyzer	Orion	901	11
Conductivity Meter	YSI	32	New
Conductivity Meter	Barnstead	PM 70-CB	3
UV-Visible Spectrophotometer	Milton Roy Co.	20D	3
Atomic Absorption Spectrophotometer	Perkin-Elmer	5000, HGA 500	5
Atomic Absorption Spectrophotometer	Perkin-Elmer	5100	6 mo
Total Organic Carbon Analyzer	O.I. Corp.	700	4
Gas Chromatograph	Hewlett-Packard	5890	1
BOD Analyzer	YSI	54A	5
Inductively Coupled Plasma Analyzer	ARL	3410	2
Inductively Coupled Plasma Analyzer	Jarell-Ash	Enviro II Polyscan	1 mo
Total Organic Halide Analyzer	Dohrmann	20A	1
HPLC/IC	Waters	510/820/484	New
Gas Chromatograph/ Mass Spectrometer	Hewlett-Packard	5890-5970B	New
Mercury Cold Vapor Analyzer	Coleman	50B	3
Purge and Trap System for Gas Chromatograph	O.I. Corp.	MPM16	3
IR Spectrophotometer	Perkin-Elmer	1600	2

Item	Manufacturer	Model	Age (years)
Large Water Bath	Blue M		3
Vortex Mixer	S/I	K-550-G	6
Autoclave	Barnstead	1250	9
Ampule Sealer	O.I. Corp.		4
Automatic Digestion Unit	Technicon	BD-40	3
Magnetic Stirrer/ Hot Plate	Corning		1
Multi-Magnetic Stirrer	Fisher		4 mo
TRPH Extractor	Dionics		1 mo
Millilab	Millipore		1 mo
Microwave Digester	CEM		2 mo

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B. Major Laboratory Equipment:

Item	Manufacturer	Model	Age (years)
Six Refrigerators 3' x 6' x 6'	Nor-Lake		7
Two Refrigerators 3' x 3' x 5'	Kenmore	106	9
Radiant Heat Oven	Lab Line	Imperial III	11
Forced Draft Oven	Blue M	OV-18C	1
Furnace	Heavi-Duty		31
Muffle Furnace	Hoskins		31
Three Fume Hoods	Labconco		12
Fume Hood	Allen-Bradley		30
Distillation System	Barnstead	A-1013	5
Distillation System	Barnstead	A-1013	2
Ion Exchange System	Millipore	Micro-Q	10
Centrifuge	IEC	2K	12
Centrifuge	IEC	EXD	25
Centrifuge	Lab Line	Imperial III	11
Centrifuge	Barnstead	1250	11
Balance	Fisher	B-5	22
Balance	Mettler	PC400	12
Balance	Mettler	K-7	22
Balance	Mettler	AE200	3
Balance	Ohaus	B300	4
Balance	Sartorius	1202	4
Ultrasonic Cleaner	Mettler		10
Sonicator	Ultrasonics	W-375	7
Roto-evaporator	Buchi	R110	8
Small Hot Plate	Lindberg		Unk
Large Hot Plate	Lindberg		3
Large Hot Plate	Lindberg		2
Small Water Bath	Blue M		8

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LIST OF TABLES AND APPENDIXES

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TABLES

APPENDIXES

LIST OF ACRONYMS/ABBREVIATIONS

A-E	Architect-Engineer
AFR	Air Force Regulation
AFB	Air Force Base
ASTM	American Society of Testing Materials
BOD	Biological Oxygen Demand
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
COC	Chain of custody form
COD	Chemical oxygen demand
COE	Corps of Engineers
DOE	Department of Energy
DQO	Data quality objective
EB	Equipment Blank
EM	Engineering Manual
EPA	U. S. Environmental Protection Agency
GC	Gas Chromatograph
HE	High Explosives
HTW	Hazardous and toxic waste
HTW QA&IH	HTW Quality Assurance and Industrial Hygiene Section
HWM	Hazardous Waste Management
ID	Identification
MRD Lab	Corps of Engineers Missouri River Division Laboratory
MTBE	Methyl tertbutyl ether
NAD	North American Data
PCBs	Polychlorinated biphenyls
psi	Pounds per square inch
PVC	Polyvinylchloride
RI/FS	Remedial Investigation/Feasibility Study
QA	Quality assurance
QAPP	Quality assurance project plan
QC	Quality control
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facilities Investigation
RPD	Relative percent difference
SAC	Strategic Air Command
SSHP	Site Specific Health and Safety Plan
SWD Lab	Corps of Engineers Southwestern Division Laboratory
TB	Travel Blank
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TRPH	Total Recoverable Petroleum Hydrocarbons
TSS	Total Suspended Solids
TWC	Texas Water Commission
USATHAMA	US Army Toxic and Hazardous Materials Agency

1.0 INTRODUCTION.

1.1 General. The purpose of this Quality Assurance Project Plan (QAPP) is to document the procedures required to ensure that all data obtained from the investigative activities in the Carswell AFB Remedial Investigation/Feasibility Study (RI/FS) are of acceptable quality. This RI/FS is being conducted under Air Force Policy for cleanup guidance, and under the format prescribed by the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). The validity and representativeness of this data must be ensured, so that the magnitude and extent of contamination can be accurately defined and remedial decisions can be made which are technically sound. Quality assurance (QA) is the Government activity required to assure desired and verifiable levels of quality in all aspects of an investigation. Quality control (QC) is the functional mechanism to achieve quality data. The QA program, administered by the Government, will ensure that the QC program will result in high quality data. This document will describe the QA/QC procedures for each aspect of the investigations which will meet the data quality objectives of this project. Procedures in this QAPP came from "Chemical Quality Data Management for Hazardous Waste Remedial Activities", ER-1110-1-263 (ref. 8), a Corps of Engineers regulation, with additional guidance from "RCRA Facility Investigations Guidance", SW-87-001 (ref. 15), "Test Methods for Evaluating Solid Waste", SW-846, (ref. 13).

1.2 Organization. This document discusses the data quality procedures and techniques to be used in the work plans for investigations at Carswell Air Force Base (AFB), Fort Worth, Texas. The study will be accomplished through the sampling and analysis of soil, bedrock, sediments, surface water, and groundwater, and the installation of monitoring wells. A description of the project is given in Section 2. Section 3 describes project organization and personnel; Section 4 discusses the quality assurance objectives for this project; Section 5 discusses the field work to be performed and the procedures to be used in drilling, well installation, and sampling of soil, rock, sediment, groundwater, and surface water; and Section 6 discusses sample handling and testing. Sections 7 through 10 discuss sample integrity, data reduction and validation, audits, and corrective action.

1.3 Deviations From Established Procedure. This section discusses procedural deviations and changes to the approved work plan. Any deviations in procedures which are temporary or involve unexpected conditions during field investigations and which will not change the objectives of the RI/FS work plan will be made by the field manager or the project manager. These changes will be documented and will be reported in the RI/FS report. In the event that deviations become necessary which could change the objectives of the RI/FS work plan, the Carswell AFB will submit, in writing, to the Texas Water Commission (TWC), a request for work plan modification. The request will include the details of the current procedures (if applicable), the proposed change, the rationale for the change, and a proposed time frame for action by the TWC. The TWC will reply in writing on their intent to act on the submitted request within a reasonable period of time after receiving the request. Once the modification has been approved by the TWC, the appropriate changes will be made in the RI/FS work plan. The modification will also be documented in the RI/FS report.

2.0 PROJECT BACKGROUND.

2.1 Site Description. Carswell AFB is the former home of the Strategic Air Command (SAC) 7th Bombardment Wing. The mission of Carswell AFB was to maintain the capability of strategic warfare and air refueling operations. The base is scheduled for closure 1 September, 1993. During the past year, military personnel have been transferring from the base. Also, the base flying mission for SAC no longer exists, as all aircraft have been moved to other bases. There is, however, a small contingency of fighter aircraft supporting the 301st Tactical Fighter Wing (Reserve) remaining at the base.

3.0 PROJECT ORGANIZATION. The Fort Worth District, U.S. Army Corps of Engineers (COE), will use a multi-disciplinary project team from the District's Geotechnical Branch to oversee all project activities.

3.1 Field Personnel. Field operations will be conducted by either the Fort Worth District, a contractor, or both. Activities will be coordinated by the COE Field Manager. The COE Field Manager will coordinate all field activities with the District Office and provide safety and quality control oversight. Each contractor will also designate a Field Manager who will coordinate activities with the COE Field Manager.

3.1.1 Fort Worth District Field Crews. District drilling crews consist of a driller, two helpers and a geologist. Water sampling crews consist of two individuals experienced in environmental water sampling. Field crews are supervised by the Chief, Investigations Section. Members of Fort Worth District field crews have worked on hazardous waste investigation projects on military installations in Texas, Oklahoma, Arkansas, and New Mexico. Crew members attend formal and informal training sessions, including hazardous and toxic waste (HTW) safety training. The average hazardous waste experience level of the water sampling crew members is approximately 2 years. The average hazardous waste experience level of the drilling crew members is approximately 6 years.

3.2 Quality Control Personnel. All RI/FS program personnel are responsible for monitoring and reviewing all procedures used in every stage of the work to ensure that data generated in the course of execution of the work plan is accurate, complete, precise and representative of the site studied. The Field Manager or a member of his staff is designated as the Quality Control Officer and is responsible for the proper execution of field QC, as discussed in Section 5.10.

3.3 Quality Assurance Personnel. Quality assurance will be performed by the Fort Worth District, Geotechnical Branch, Hazardous Waste Management (HWM) Section. This section reports to the Chief, Geotechnical Branch and will be responsible for office and field audits and reviewing laboratory audits. The audit function is discussed in Section 9. HWM Section will oversee performance and system audits of this investigative program, perform an on-going review of QA procedures, and help coordinate QA training for project personnel.

3.4 Laboratory. Analytical testing and quality control testing is performed by contract laboratories. QA testing is performed by the Corps of

Engineers Southwestern Division Laboratory (SWD Lab). SWD Lab's responsibilities include procuring analytical services, analyzing QA samples, and validating chemical data. Details on SWD Lab organization, responsibilities and key personnel are contained in their QA/QC Plan, which is on file in the Fort Worth District office.

3.4.1 <u>Sampling by Fort Worth District Field Crews</u>. When sampling is performed by Fort Worth District field crews, SWD Lab receives shipments of samples from the field, which it may pass on to its contract laboratories, except for the QA samples. If the analyses are not performed by SWD Lab, the contract laboratories perform the analyses and return the results to SWD Lab.

3.4.2 <u>Sampling by Contract Field Crews</u>. When sampling is performed by A-E contractors, their laboratories receive all samples except the QA samples, which are sent to SWD Lab. Contract laboratories must be validated, as described in Section 3.4.3. While validation periods vary for each contract laboratory, a list of currently valid laboratories is available from the Fort Worth District HWM Section.

3.4.3 <u>Laboratory Validation</u>. SWD Lab and all contract laboratories are validated by the Corps of Engineers Missouri River Division Laboratory (MRD Lab). The validation process involves review of their laboratory quality management manual, laboratory performance on audit sample analyses, and an on-site inspection. This validation process is discussed in detail in Appendix C of ER-1110-1-263 (ref. 8).

4.0 QUALITY ASSURANCE OBJECTIVES. The data quality objectives (DQOs) of this project have been chosen to meet the goals of site characterization, risk assessment, and remedial design. These goals can be achieved with analytical support between Level III and Level IV, as described in ref. 14. As described in ref. 7, the minimum internal data reporting requirements which will be required of all analytical laboratories includes the following:

* Sample identification numbers will be cross-referenced with laboratory IDs and QC sample numbers.

* The laboratory will note problems with arriving samples on an appropriate form.

* Each analyte will be reported as an actual value or less than a specified quantitation limit (listed in Appendix B). Each questionable result (based on laboratory QC) will be reported as such. Soil samples will be reported on a dry weight basis with the moisture content. Dilution factors, extraction dates, and analysis dates will also be reported.

* QC samples will include laboratory blanks, surrogate spikes, matrix spikes, laboratory duplicates, field duplicates, and field blanks. These samples will be analyzed as specified in the analytical method or as specified in this QAPP.

The data developed from the investigations described in this work plan should meet the objectives discussed below with respect to precision, accuracy, representativeness, completeness, comparability, and sensitivity. The majority of this data will be developed in the laboratory from the analysis of field samples and the remainder will be measured in the field.

4.1 Precision. Precision is a measure of the degree of reproducibility of an analytical value and is used as a check on the quality of the sampling and analytical procedures. Precision is determined by analyzing replicate samples. The significance of a precision measurement depends on whether the sample is a field replicate, lab replicate, or a matrix spike replicate. Field replicates are taken at the rate of 10% or one per batch (each daily shipment of samples from a site), whichever is greater. Precision of the analytical method, at each stage, is determined by calculation of a relative percent difference (RPD) between duplicate analytical recoveries of a sample component, relative to the average of those recoveries:

$$RPD = \frac{|C_2 - C_1|}{(C_2 + C_1) \div 2} \times 100\%$$

where C_1 = analyte concentration in the sample,
C_2 = analyte concentration in the sample replicate,

and $|\;|$ = an absolute value (It is customary to express RPD as a positive number).

These calculations are usually performed on matrix spikes and matrix spike duplicates.

4.2 Accuracy. Accuracy is the degree to which a measurement agrees with the actual value, i.e., the amount of measurement bias. Accuracy is expressed as a percent recovery of a known concentration of reference material. The accuracy of an analytical procedure is determined by the addition of a known amount of material (matrix spike) to a field sample matrix or a standard matrix. A standard matrix is made up of distilled water or sterile, clean soil with approximately the same physical properties (porosity, permeability, plasticity, grain size, etc.) as the field sample. The field sample matrix is described as all components of the sample mixture except the analyte (the compound being analyzed). The lab will be required to perform matrix spiking on 10% of field samples, as well as on 5 to 10% of standard matrix samples. Field sample matrix and standard matrix sample spiking show how the sample matrix-analyte chemical interactions affect the analytical results. The matrix behavior of the spiked field sample will be comparable to that of the matrix of the original sample. The matrix spike consists of a known amount of an analyte which is added to the matrix before analysis. After analysis for the spike is completed, the accuracy of the procedure is expressed as a percent recovery as shown by the following equation:

$$\%\ recovery = \frac{(C_2 - C_1)}{C_0} \times 100\%,$$

where C_0 = amount of analyte added to the sample matrix,
C_1 = amount of analyte present in the unspiked sample matrix (equal to zero for the standard matrix),
and C_2 = amount of spiked material recovered in the analysis.

Typically, the amount of a reference analyte spiked into a field sample matrix is specified by the laboratory quality control program, or 3 to 5 times the background concentration of the analyte in the sample matrix. Samples cannot be spiked for all organic compounds which could possibly exist in the field sample matrix, however, a set of surrogate compounds, each of whose physical and chemical properties is similar, is used as surrogate matrix spikes, or surrogates. Acceptable recovery ranges for each class of organic compounds are discussed in the analytical methods for each parameter.

4.3 Representativeness. Representativeness expresses the degree to which sample data accurately and precisely represent actual site conditions. The determination of the representativeness of the data will be performed by:

* Comparing actual sampling procedures to those outlined in the work plan.

* Identifying and eliminating nonrepresentative data in site characterization activities.

* Comparing analytical results of field duplicates with samples to determine the spread in the data.

* Examining blanks for cross contamination.

Representativeness is a qualitative determination. The representativeness objective of this work plan is to eliminate all non-representative data.

4.4 Completeness. Field completeness will be assessed by comparing the number of samples collected to the number of samples planned. Analytical completeness will be assessed by comparing the total number of samples with valid analytical results to the number of samples collected. The overall project completeness is, therefore, a comparison between the total number of valid samples to the number of samples planned. The results will be calculated following data validation and reduction. Completeness (C) is determined by:

$$C = \frac{P_1}{P_0} \times 100\%$$

where P_0 = total number of samples planned,
and P_1 = number of valid data points.

A value of 90% or higher is the goal. For values less than 90%, problems in the sampling or analytical procedures should be examined and possible solutions explored.

4.5 Comparability. Comparability is a qualitative measure of the confidence with which one data set can be compared to another. These data sets include data generated by different laboratories performed under this work plan, data generated by laboratories in previous investigative phases, data generated by the same laboratory over a period of several years, or data obtained using differing sampling techniques or analytical protocols. The comparability objectives of this work plan are (1) to generate consistent data using standard test methods; and (2) to salvage as much previously generated data as possible.

4.6 Sensitivity. Sensitivity is a general term which refers to the calibration sensitivity and the analytical sensitivity of a piece of equipment. The calibration sensitivity is the slope of the calibration curve evaluated in the concentration range of interest. The analytical sensitivity is the ratio of the calibration sensitivity to the standard deviation of the analytical signal at a given analyte concentration. The detection limit, which is based on the sensitivity of the analysis, is the smallest reported concentration in a sample within a specified level of confidence. Quantitation limits represent the sum of all of the uncertainties in the analytical procedure plus a safety factor. The detection limit is a part of the quantitation limit. Quantitation limits are given in Tables B-4 to B-9.

5.0 FIELD OPERATIONS. This section discusses drilling, well installation, sampling, decontamination, waste disposal, other field procedures, and field QA/QC.

5.1 Oversight.

5.1.1 Field Manager. Field activities will be overseen by the Field Manager, who will meet with the sampling and drilling crews prior to the start of the project. The purpose of the meeting is to review the objectives of the investigation and resolve any unclear details. The Field Manager will discuss drilling locations and clearances, sampling parameters and equipment, decontamination, and any special considerations of this site. The Field Manager is responsible for ensuring that sampling procedures as discussed in this work plan are followed, that the paperwork is completed correctly, and that the quality control procedures are correctly implemented. The Field Manager will serve as a liaison between the sampling crew and the laboratory and between the field crews and the project manager.

5.1.2 Drill Rig Inspector. A geologist, who will have a degree in geology and drill rig experience, will serve as an inspector for all drilling activities. The inspector will prepare and describe samples, cuttings, and core, monitor drilling operations, oversee well installation, record ground-water data, and prepare well diagrams and geologic logs.

5.2 Drilling. Techniques utilized to advance borings are dependent upon the specific problems and objectives at each location, such as the type of samples required, depth of well to be installed, and the presence of caliche and uncemented zones. Dry or air drilling techniques will be used whenever possible. However, drilling with water or mud may be required in instances where dry or air techniques are attempted and fail. In methods utilizing air as the circulating medium, cuttings will be routed directly through a cyclone, a device which separates air and cuttings. This method is discussed in Section 5.2.6.1. Cuttings which settle out from the cyclone will be collected and disposed of as discussed in Section 5.11. Compressed air will be passed through an in-line filter to avoid introduction of oil or other impurities into the borehole. Drill pipe, bits, barrels, casing, and other equipment used below ground will be steam cleaned as discussed in Section 5.9. Drilling techniques which may be used in drilling boreholes and monitoring wells are discussed below. Several different techniques may be used at each location to produce the best results. These techniques include:

- Hollow stem augering

* Dual wall reverse circulation drilling

* Dual or triple wall reverse circulation percussion hammer drilling

* Drill-through driven casing

* Conventional air, water, or mud rotary drilling

5.2.1 **Hollow Stem Auger**. This drilling technique utilizes hollow flight augers with a cutting head attached to penetrate the formation. A sampling device, such as a split spoon, is lowered through the auger string to take a drive sample. Variations of the method include use of a pilot bit or wireline core sampler in the center of the auger assembly. Use of a hollow stem auger has the following advantages:

* Maintains hole stability in unconsolidated or poorly consolidated materials.

* Allows drilling without added fluids.

* Permits good formation sampling with split spoon, Shelby tube, or wireline core sampler.

* Allows for recognition of saturated zones.

* Produces large diameter holes if formation is sufficiently stable to stand open when the augers are retracted.

* Large internal diameter augers (6 inches or greater) can be utilized as temporary surface casing for other drilling techniques.

* Waste is limited to the auger cuttings which are collected at the top of the hole. These are generally placed into a collection container as discussed in Section 5.11. Dust is minimal. Liquid waste is not present unless a saturated zone is encountered.

Limitations include:

* Difficulty of penetration below 200 feet.

* Risk of losing auger flights (and hole) at excessive depths.

- Inability to use the technique for well installation because of depth limitations.

- Need for air monitoring for volatiles in potentially contaminated areas.

This method of drilling will primarily be useful for determining stratigraphy and obtaining samples at shallow to moderate depths (200 feet). The relative ease of obtaining samples unaffected by any drilling fluids is a key consideration in employing this method.

5.2.2 Dual-Wall Reverse Circulation Air Drilling. This drilling method was developed in Canada for penetration of glacial till, alluvium, permafrost and other unstable formations. It is a modification of conventional air rotary drilling. Two drill pipe strings are utilized (outer and inner), with a drill bit attached only to the inner drill pipe. The drill bit has a slightly greater diameter than the outer drill pipe so the casing essentially drops by gravity into the drill hole. Air is circulated down between the inner and the outer casing past the bit and up the inner casing with the cuttings which are passed through a cyclone. Advantages of this system include:

- Rapid drilling through either unconsolidated or consolidated materials is possible.

- Cuttings are indicative of the formation currently being drilled since caving from higher in the borehole is not present. The air circulation returns cuttings to the surface very rapidly allowing accurate logging.

- Recognition of saturated zones is indicated by water reaching the surface with the cuttings. Water levels can be determined through the drill string.

- Small diameter geophysical logging tools can be run through the casing.

- Borehole integrity is maintained by the outer casing.

- System is capable of achieving depths of up to 1000 feet.

Limitations include:

* Sampling with split spoon or other samplers may not be possible depending on bit size and type. Therefore, collection of whole samples may be difficult or impossible.

* Only small diameter well casings can be installed through drill string (generally 2 inches or less). Installation of filter packs is usually not possible.

* Inner drill string and bit cannot be retracted through outer casing. All drill string must be tripped out of the hole.

5.2.3 Dual or Triple Wall Reverse Circulation Percussion Hammer Drilling. This method is similar to dual wall reverse circulation air drilling in that two drill pipe strings are used with air circulated down the outer and up the inner to remove the cuttings from the bit and bring them to the surface. The outer casing is fitted with an open-faced drive bit and is driven by a percussion hammer rather than rotated into the ground. The impact is applied only to the outer pipe. The inner and outer drill pipes are an integral unit which does not allow retraction of the inner casing. Drill string with a 9-inch outside diameter and 6-inch inside diameter is commonly available. Dual wall equipment with an inside diameter of 8 inches will be available by the time field investigations commence at Carswell which will allow installation of 5-inch diameter wells. A variation of this method utilizes triple wall casing. This system also employs a dual wall drill string with an additional outer casing. The outermost casing is simultaneously driven with the outer pipe of the dual wall casing, but is not physically joined to it. This allows retraction of the inner drill casings while leaving the third (triple wall) in place to maintain borehole integrity. Applications of this variation include installation of large diameter wells at shallow to moderate depths, and use as temporary casing to allow insertion of conventional rotary equipment or other tools. Depth of penetration with a triple wall casing is probably limited to a few hundred feet, but will depend on site specific conditions and equipment capabilities. This variation may be very helpful in increasing drilling rates through caliche zones in the upper part of the section. Penetration to total depth with the triple wall is not essential since the dual wall alone allows installation of 5-inch diameter wells.

Specific advantages of dual and triple wall reverse circulation percussion drilling include:

* Good penetration rates through unconsolidated material varying from clay to cobbles or even boulders.

* Detection of saturated zones and measurement of water levels through the drill stem.

* Installation of monitoring wells through drill string.

* Sampling with conventional samplers through drill string without the necessity of tripping out of the hole.

* Ability to run geophysical logs through drill string.

* Minimization of flow of fluids along the annulus, which is cased during all drilling operations.

* Ability to drill with air and maintain hole integrity in unstable formations.

* Flexibility to alternate with conventional air rotary to penetrate resistant zones if triple wall technique is utilized.

* Availability of single rigs capable of utilizing this methodology as well as dual wall reverse circulation rotary, and conventional rotary drilling.

Limitations of this method include:

* Penetration of consolidated layers may be difficult with the unassisted dual wall system.

* Required operational depths at Carswell AFB of approximately 300 to 500 feet and large diameter require use of only maximum capability rigs.

* Risk of casing becoming stuck at depth. Rigs with a very large pulling capacity are required.

The dual wall percussion method allows the same ease of sampling as use of hollow stem augers, while being effective at depths of 450 to 500 feet.

5.2.4 <u>Drilling Through Driven Casing</u>. As in the methods above, this method effectively stabilizes the borehole during drilling in unstable formations, without requiring water or mud. In this system an outer casing is driven into the ground around and above an advancing rotary drill bit and pipe. The bit typically is smaller in diameter than the internal diameter of the driven casing, but it may also be an underreamer. If the underreaming bit is an eccentric (off-centered) type, it is possible to underream and still retract the drill string while leaving the driven casing in place. With underreaming the efficiency and ease of driving the outer casing is increased. The driven casing is fitted with a drive shoe. Air is circulated down through the center drill pipe and out the bit, then up through the driven casing. Essentially, this is conventional air rotary drilling with the addition of an outer casing to allow drilling in unconsolidated formations. Advantages of this system include:

- Borehole stability is maintained by the casing in unconsolidated formations.
- Penetration rates are rapid in unconsolidated material, and use of the bit allows successful penetration of resistant or consolidated layers.
- Cuttings are not mixed with material from higher in the borehole.
- Recognition of saturated zones and measurement of water levels is possible.
- Whole soil samples can be obtained through the outer casing when the inner drill string is retracted.
- Wells (5 inch and larger) can be installed within the outer drive casing.

Limitations include:

- The inner drill string must be retracted from the hole to allow sampling with split-spoon or Shelby tube.
- At depth, the risk of stuck casing increases.

5.2.5 <u>Conventional Air, Water, or Mud Rotary Drilling</u>. In this method a rotary drill bit and pipe are used to advance the hole. The circulating fluid (air, water, or mud) is pumped down through the drill string and out the bit recirculating to the surface through the open annulus. Advantages of this system include:

* Rapid penetration of most types of formation material.

* Rigs, drill pipe, and bits are commonly available for virtually any desired hole diameter.

* Drilling depths of hundreds to thousands of feet are feasible.

* Allows split-spoon and Shelby tube sampling in unconsolidated materials. Denison samplers can be used in liquid-filled holes.

* Virtually any type of geophysical log can be run in a liquid-filled open hole.

* Allows recognition of saturated zones and measurement of water levels if air has been used as the circulating fluid.

* Use of mud allows successful drilling and well installation in most types of formations.

Limitations include:

* Water or mud must be used to maintain hole stability in unconsolidated material such as alluvium.

* A large volume of cuttings and potentially contaminated fluids is produced.

* Recognition of saturated zones is difficult to impossible if water or mud are used.

* Significant infiltration of fluid into unsaturated formations may occur.

* Cuttings may require washing to be logged and will be mixed with material from layers higher in the borehole.

* Formation damage resulting from invasion of drilling fluids will increase required well development effort and may permanently

affect well performance and groundwater sample quality.

* Drill string must be retracted from the hole to use most sampling devices.

* Water or mud washing of samples may make them unusable for chemical analyses.

5.2.6 Drilling fluids. Drilling fluids are used to lubricate the bit, remove cuttings and keep the boring open. Different materials perform these tasks differently and are discussed below.

5.2.6.1 Air. Air is used primarily to evacuate cuttings from the hole. Its advantage is that it does not moisten samples and compromise their usefulness for testing and it does not mask water-bearing zones. Air and cuttings leaving the hole are collected in a cyclone, located about 10 feet from the work area. The purpose of the cyclone is to minimize dust produced in the drilling. Air is discharged from the top of the device and cuttings settle out and are collected in a container.

5.2.6.2 Water. Water may be used in cases where air rotary methods do not work. In such cases, potable water will be provided by Carswell AFB. The water will be accessible from the work site and will be analyzed as needed for the same parameters as in the sampling program.

5.2.6.3 Mud. Mud is water with bentonite with or without other additives. Bentonite adds viscosity and aids in keeping the boring open. Additives, if used, will be selected with care to ensure that the groundwater chemistry will not be altered. A specialized type of mud is foam, which is made of a biodegradable polymer with properties similar to soap. It aids in lubrication of the bit and reducing dust from air drilling methods.

5.2.7 Soil and Rock Samplers. Sampling equipment to be used in conjunction with the drilling techniques discussed above is described in this section. Other types of sampling equipment may be used depending on what is available from the drilling contractor. Sampling techniques for soil and rock are discussed in Section 5.7.3.

5.2.7.1 Rockbit. A rockbit will be used primarily to advance the borehole. It produces cuttings which are removed by air or other fluids. Cuttings are useful for lithologic identification and moisture approximation (if drilled with air). Cuttings are not suitable for any type of sample.

5.2.7.2 <u>Core Barrel</u>. A core barrel is a double-walled sampling device with a bit located on the outer barrel. It is used by itself, or modified, and used with other types of drilling equipment. A core barrel produces an undisturbed sample suitable for chemical or physical tests. Drill fluid, if present, should be removed from the sample to prevent moisture penetration. A sample of core, if encased in wax, is suitable for permeability determinations and bulk density as well as physical tests for disturbed samples.

5.2.7.3 <u>Denison Barrel</u>. A Denison barrel is also a double-walled sampling device similar to a core barrel but shorter. The inner barrel is fitted with an aluminum sampling tube 3 feet long. It also takes an undisturbed sample, which is placed into the sampling tube as it is drilled. The tube is removed from the barrel, capped, and waxed. It takes good samples in poorly consolidated materials. Denison samples are suitable for the same types of tests as core samples.

5.2.7.4 <u>Split Spoon</u>. A split spoon is a small diameter sampling device which is driven into the soil with a drive hammer. It is frequently used inside hollow stem augers or other types of casing. The sample is representative of the materials encountered, but is not undisturbed. It can be used for chemical tests or physical tests not requiring an undisturbed sample such as Atterberg limits, cation exchange capacity, soil pH, grain size distribution, moisture content, or clay mineralogy.

5.2.7.5 <u>Shelby Tube</u>. A Shelby tube is a thin-walled sampler which is pushed into the soil. It takes samples primarily in unconsolidated, cohesive materials. A Shelby tube might be useful in sampling near surface materials or playa sediments. It does not produce an undisturbed sample for purposes of laboratory testing.

5.2.8 <u>Geologic Logs</u>. The strata encountered during drilling will be described in detail, using the Corps of Engineers Drilling Log form (Eng Form 1836). The log will describe each lithologic unit encountered, groundwater information, sample depths, and drilling methods. The descriptions of core and other samples will include lithology, color, grain size and range of grain size, secondary minerals such as carbonate cement, moisture content, sedimentary structures, presence and general orientation of fractures, and other data determined to be pertinent by the geologist. Boring descriptions will be determined from geophysical logs or from characterization of cuttings and drill action, where samples or core are not taken. A geologic log form is given in Appendix A.

5.2.9 Borehole abandonment. All borings not converted into monitoring wells will be abandoned by filling with a cement grout. The grout will have the composition as described in Section 5.3.5.1. After the grout has dried, the settlement depression will be filled to the surface with additional grout.

5.3 Well Installation.

5.3.1 Types of Well Installations. Wells will be drilled using one or more of the methods listed in Section 5.2. The type of well expected to be installed at Carswell AFB:

* Shallow groundwater monitoring well.

Wells will be installed at an approximate depth of 30 feet for the shallow groundwater zone. Unforeseen site-specific field conditions may require modification, but general design and well construction/use objectives will not be affected.

5.3.2 Shallow Aquifer Monitoring Well.

5.3.2.1 Well Casing. Four-inch nominal diameter, flush-threaded (F480), schedule 80 PVC casing will be installed from the screen to approximately three feet above the surface. Dependent upon the type of drilling method, centralizers will be used as needed to keep the casing centered in the well bore. Centralizers are not necessary when dual-wall drilling systems are used.

5.3.2.2 Riser and Cap. Surface construction of well pads, covers, etc., will comply with Texas Water Commission requirements. Approximately 3 feet of well casing will be left above ground and enclosed in a protective steel pipe. The protective casing will extend two feet below the ground surface and will have a locking cover to prevent entry of unauthorized personnel and rainwater. A four by four-foot 3000 psi concrete pad, four to six inches thick, will be poured around the protective casing at the ground surface, sloped to promote drainage. A surveyor's bolt will be placed in the concrete pad adjacent the protective covering to serve as a ground level reference. Four metal posts will be placed in the concrete pad to protect the well.

5.3.2.3 Screen. Wells will be screened with four-inch diameter stainless steel wire-wrap screen. The shallow aquifer saturated zone may be subject to seasonal or other temporal variations in thickness. The screen will be placed ten feet above the top of the saturated zone and extend to its base to ensure that installed wells will intercept the top of the saturated zone. Due to the varying thickness of the shallow groundwater zone, the length of screen may vary from 15 to 30 feet. Screen opening size will be 0.01 inches unless formation grain size indicates this is inappropriate. The Field Manager may elect to have an assortment of screen sizes available early in the drilling program. It is anticipated that standard sizes will be known based on boring results as the investigations proceed.

5.3.2.4 Sump. A three-foot long, four-inch diameter stainless steel sump below the screen is proposed for those wells that have a sufficient thickness of the fine-grained zone (i.e., where the shallow layer is at least more than three feet thick). It is possible that the shallow zone may inadvertently be completely penetrated during drilling if it is only a few feet thick. Should this occur, the bottom of the borehole will be plugged back with bentonite or other appropriate material above the base of the shallow unit before operations proceed.

5.3.2.5 Filter Pack. A sand filter will be placed in the annulus between the well screen and the borehole from the bottom of the hole to approximately four feet above the top of the screen via a tremie pipe (pumped wet or dropped dry), or down the outer drill pipe as appropriate. A factory prepared and washed 20-40 filter sand is anticipated for most applications. However, a variety of sand gradations will be available during early stages of the investigations to ensure the filter pack is appropriate for the formation characteristics. The sand will be stockpiled in an uncontaminated area and transported in the bags to the well site.

5.3.2.6 Seal. An approximately three-foot thick bentonite seal will be placed above the filter sand in the well annulus. This will be accomplished by using pellets or a gel and installing via a tremie pipe by dropping or pumping. If well conditions and drilling method permit, the seal may be dropped down the annulus between the drill pipe and the well casing.

5.3.3 Materials Used in Well Construction.

5.3.3.1 Bentonite. Well seals will be composed of bentonite pellets, flakes, powder or gel as appropriate to ensure successful installation. Bentonite powder may be used during drilling. The manufacturer, brand, and amount of bentonite used will be recorded on the field data sheet and in the field journal. Any other drilling additives must meet the same requirements for non-interference with groundwater monitoring objectives as high purity bentonite. If used, these other additives will be documented as to source, manufacturer, and chemical composition. The use of any additives (e.g., drilling mud polymers or foams) will be avoided during drilling operations in saturated zones which will be subsequently monitored.

5.3.3.2 Grout. Grout will be used for monitoring well construction and borehole abandonment. The grout will consist of a pumpable mixture of water, cement, and approximately 5% bentonite. Grout will be pumped or poured through a tremie or into an open hole or pipe. The quantities of grout used will be recorded on the well log and in the field journal. Grouting will be accomplished in an appropriate manner for the specific application. Generally, grout will be pumped through a tremie pipe placed in the annulus just above the previously installed seal. The grout will be pumped in stages (5 to 10 feet at a time) with the tremie being withdrawn to the top of the preceding grout level each time. This will aid in achieving an acceptable grout while minimizing the probability of voids in the annulus.

5.3.3.3 Riser Pipe and Screen. Screens will be stainless steel in order to provide a strong but inert material which will be in contact with the groundwater. Riser pipe in the upper zone wells will also be stainless steel because of the wall and thread strength required for an installation at a depth of 500 feet. Riser pipe in the perched wells will be schedule 80 PVC.

5.3.4 Development. After the monitoring well installation is completed, wells will be developed to remove drill fluid and cuttings as well as fines from the sand filter which might clog up the well screen. Each well will be bailed and/or pumped until the water runs clear. Water and cuttings will be disposed of in accordance with Section 5.11.

5.3.5 Well schematics. A well diagram will be prepared for each well which will contain all pertinent information concerning the well, such as drilling method, installation technique, diameter, casing materials, depth, locations of the bentonite seal, screen length and opening size, filter pack length and gradation, grout, and the riser pipe height. A geologic log will also be prepared for each well. Log and well schematic forms are shown in Appendix A.

5.3.6 Well Certification. A signed certification shall be completed for each monitoring well. This certification shall include the drilling log, survey information, as-built construction details, and a statement certifying that the well was installed in accordance with and in compliance with the design and all applicable regulations.

5.4 Location Surveys. All borings and monitoring wells will be physically located by survey. The survey contractor will be required to meet or exceed a Third Order Class 1 survey, with an accuracy of 1 in 10,000. This accuracy equates to approximately 0.01 foot horizontally and vertically. The contractor will use one of 70 bench marks set from monumentation established by the U. S. Coast and Geodetic Survey. Horizontal control will be in accordance with Texas State Plane Coordinate System, North Zone, using NAD 83, and vertical control will be in accordance with sea level datum of the National Geodetic Survey 1929. The contractor will be prohibited from exceeding 300 feet in each leg of his vertical traverse and from closing on the same bench mark.

5.5 Geophysical Surveys.

5.5.1 Surface Geophysics. Surface geophysics will be used to determine stratigraphy and the continuity of lithologic units across the base and the playas and at specific sites. The following surveys may be used during the RI/FS at Carswell AFB.

5.5.1.1 Seismic Surveys. Seismic surveys include both reflection and refraction. They measure the travel time of a generated wave through or reflected from subsurface layers. These surveys give reliable information about the continuity and density of these layers.

5.5.1.2 Electrical Resistivity. Electrical resistivity measures the electrical resistance of subsurface layers. An electrical current is implanted in the ground with two electrodes, and the potential difference is measured by non-current carrying electrodes. The depth of penetration is determined by electrode spacing. Resistivity is a measure of the porosity and permeability and the amount and dissolved ion concentration of the pore water.

5.5.1.3 Ground Penetrating Radar. Ground penetrating radar measures the travel time and amplitude of reflected high frequency radio waves. A small antenna, moved slowly across the ground surface, radiates energy downward. Reflected energy is continuously recorded and a shallow subsurface profile is generated. Radar is best for locating near surface strata and anomalies. It is particularly good for locating buried pipes, drums, and tanks. It will be used in this site-specific capacity.

5.5.1.4 Other Surveys. Other surveys which could be performed include electromagnetic conductivity and magnetometer surveys. Electromagnetic conductivity determines the horizontal and vertical variations of conductivity in the shallow subsurface, and magnetic surveys are used to locate magnetic material in a similar manner as ground penetrating radar, but with greater depth of penetration.

5.5.2 Downhole Geophysical Logs. Geophysical logging will be performed in all borings of significant depth. Specific applications will be decided in the field based upon boring depth, location, casing present, and condition. Geophysical logs may not be run in cases where borings are only a short distance (few feet to tens of feet) from holes which have been previously logged. Geophysical logs will be used to yield information on lithology, stratigraphy, water saturation, formation density, porosity, well construction/condition, and to allow correlation of boreholes. Specific types of logs which may be employed during investigations at Carswell are discussed below.

5.5.2.1 Spontaneous Potential. This log is applicable in water or mud filled open holes. Natural electrical potential resulting from the interaction of borehole fluids, formation matrix, and formation fluids are measured such that the log records vertical variation of this voltage. Typically this log is used for correlation and to define bed thickness.

5.5.2.2 Natural Gamma Ray. This log can be run in dry holes or liquid filled holes, and can be run through PVC or metal casing. A detector in the borehole measures natural radiation in the formations intercepted by the borehole. The natural radiation is a function of the concentration of gamma emitters present (potassium, thorium, uranium). Generally, the concentration of these elements is higher in clays than other lithologies. The log is used for correlation, defining bed thickness, and in lithologic determination.

5.5.2.3 Resistivity Logs. This type of log is applicable in fluid-filled open holes. An electrical current is either applied directly to the borehole environment or induced. A variety of this type of electrical source logs are available commercially, e.g., induction logs, single and multiple point resistivity logs, lateral logs, microresistivity logs, and microlateral logs. Typical uses include thin bed recognition, correlation, and estimation and/or calculation of water saturation.

5.5.2.4 Neutron Logs. This log can be run in open or cased holes, in water or a dry borehole. The logging sonde contains a neutron emitter (plutonium-beryllium or americium-beryllium). The neutrons from the source react with hydrogen nuclei in the formation to produce secondary gamma radiation and lower energy (thermal) neutrons. Generally, the detector responds to the gamma radiation. In water saturated formations, neutron response is a function of formation porosity. The neutron log can also be used to estimate water saturation in the vadose zone if total porosity is known.

5.5.2.5 Bulk Density (Gamma Gamma) Log. This log is primarily useful in uncased holes, but may be modified to yield useful results in cased holes, particularly if the casing is non-metallic. Spacing of the source and detector are varied to allow various depths of investigation (i.e., diameter around the borehole). The sonde contains a medium-energy gamma ray source which is placed against the borehole wall. The detector measures back scattered gamma rays which are proportional to electron density of the formation. Electron density is related to the true bulk density which in turn depends on the density of the rock matrix material, the formation porosity, and the density of the fluids filling the pores. The log is typically used to determine porosity and lithology. It is particularly useful when a neutron log is also available.

5.5.2.6 Caliper. The caliper log is generally run in uncased holes, but may also be run in existing wells where casing deterioration is suspected. The sonde uses three or more extending arms which provide a measurement of well diameter. This allows assessment of washout zones and can be used to calibrate neutron log porosity measurements.

5.5.2.7 Acoustic Bond Log. This is a shallow investigation (i.e., short diameter) sonic velocity log. It is run in cased holes. The primary application of this log is to assess the quality of well construction. It may be run in new wells if concern over the grout bonding to the formation and casing exists, or in existing wells.

5.6 Physical Groundwater Testing.

5.6.1 Equilibrium Water Level. Once the well is completed, both the water level and bottom of well will be measured to the nearest 0.01 foot. Measurements will be marked from the top of the casing and recorded in the field journal and other appropriate forms. An electric probe will be used to establish equilibrium water levels and bottom of the well depth. Any well condition problems noted should also be recorded in the field journal. The probe will be rinsed in Type II reagent grade water immediately before being lowered into the well and immediately after removing it from the well. If the well is heavily contaminated, additional cleaning of the probe may be required as described in Section 5.8.

5.6.2 Slug Tests. Slug tests are performed in order to determine the hydraulic parameters of the aquifer, and may be conducted in both the perched and Ogallala aquifers. The purpose of this test is to determine permeability of a stratum, taking into account bedding planes, fractures, and other discontinuities. Slug tests can give a more reliable indication of permeability than a laboratory test, which is performed on a very small test specimen. A known volume (slug) of water is removed from a well, and the rate of recharge is recorded.

5.6.3 Packer Tests. Packer tests may be used during drilling of the monitoring wells, to determine the permeability of discrete lithologic intervals. Results from the packer tests effectively delineate a permeability profile for the strata encountered during well boring, and yield useful information with regard to both vertical and horizontal groundwater movement in the vadose and phreatic zones. Each stratum to be tested in the borehole is sealed off by a pair of inflated packers. If the test is performed during drilling, then the bottom of the hole will serve the same purpose as the second packer. Water will be pumped under pressure into the zone between the packers. The pump rate and pressure will be used to calculate the permeability.

5.6.4 Pump Tests. A pump test is also used to determine aquifer characteristics. One well is designated as the pump well and additional wells are used for measuring water levels during the test. The test is conducted for a sufficient period of time to establish equilibrium conditions. During the pumping period, water levels are measured in all of the wells with enough frequency to establish a drawdown rate. After pumping has ceased, the wells are again measured to establish a recovery rate. A pump test is more expensive and difficult to administer than slug tests or packer tests, but yields information pertinent to an area, rather than just a point as is the case with the above. It can also determine a cone of depression and boundary conditions, such as permeability distribution. Groundwater removed from a pump test will be disposed of in accordance with Section 5.11, if it comes from a contaminated area.

5.7 Sampling Procedures. Samples are portions of a solid or liquid material which are tested for a set of parameters. These may be physical tests or chemical tests. Table 5-1 lists the parameters which are likely to be tested at the various sites at Carswell AFB. A complete list of parameters under each grouping are given in Appendix B. Additional parameters could be added if necessary to properly characterize the site.

TABLE 5-1 PARAMETERS TO BE TESTED AT CARSWELL AFB

	water		soil	
parameter	groundwater	surface water	soil/rock	sediment
volatiles	X	X	X	X
semivolatiles	X	X	X	X
RCRA metals	X	X	X	X
cyanide	X	X		
quality indicators	X			
limnological parameters		X		
field parameters	X	X		

5.7.1 Groundwater sampling.

5.7.1.1 Open and Dedicated Wells. Open wells are wells which will not be fitted with dedicated purging and sampling equipment. They will be purged with a portable purging system and sampled with teflon bailers. The portable system typically consists of a submersible or purge pump and a discharge pipe. The purge pump will be operated by a portable generator. The generator will not introduce oils into the well during purging operations. After purging is completed, the equipment will be removed from the well and cleaned thoroughly with distilled water and a nylon brush. The bailers will be taken to the field lab and cleaned as described in Section 5.9. If the well shows evidence of heavy contamination, the purging system will cleaned in the same manner as the bailers. Some monitoring wells may be equipped with dedicated purge pumps and/or bladder or piston sampling pumps. Any active production wells on or off-site which contain dedicated production pumps will be purged and sampled from the production pumps, if sampling is required.

5.7.1.2 Well Evacuation Procedures. Prior to sampling, the stagnant water within the well (five casing volumes) will be removed so that fresh formation water can enter. If after five volumes, pH and conductivity have not stabilized, then additional volumes will be removed. Handling and disposal of purge water is discussed in Section 5.11. The well should be sampled as soon as possible after purging. For slowly recharging wells, sampling should take place as soon as sufficient recharge has occurred to fill sampling containers. The sampling crew will record the recharge rate, if not immediate, the date, time, and rate of purging, and any unusual conditions noted with this operation. Non-dedicated purging equipment will be thoroughly scrubbed and rinsed with Type II reagent grade water each time it is used. Under heavily contaminated or unknown conditions, additional rinses will be performed, as discussed in Section 5.9.

5.7.1.3 Sampling. Wells will be sampled with a dedicated teflon bladder pump, a piston pump, or a teflon bailer. The pumping rate should be about 100 ml/minute, which is low enough to prevent agitation. Bailers will be slowly lowered into the wells. A generator, if used, will be placed downwind of the well to prevent fumes from contaminating the sample. Each pre-cleaned sample container will be filled directly from the bailer or discharge tube of the pump. A common container will not be used to fill sample bottles. Sampling equipment and containers will be kept from ground contact, and may be laid on plastic sheets on the ground. Upgradient wells will be sampled before downgradient wells. Sampling will proceed from the least contaminated to the most contaminated, if that information is available.

Samples of groundwater for chemical analysis are taken in the following order:

- Field parameters
- Volatile organics
- Semivolatile organics
- Metals
- Cyanide
- General quality indicators

Field analyses (pH and conductivity) will also be performed. Table B-1 lists container, preservation, and handling requirements for each parameter, and Table B-2 lists holding times. The sequence of operations for groundwater sampling is as follows:

- Purge slow-recharging wells at the outset of the sampling day.
- Purge and sample other wells.
- Sample slow rechargers, if possible.
- Preserve the samples.
- Package and ship the samples to the laboratory.

5.7.1.4 Immiscible Layers. Immiscible liquid layers are not expected to be encountered; however, procedures for dealing with immiscible layers in groundwater are included in this plan and are listed below.

* The level of the immiscible layer surface and water interface will be determined with an electronic probe. The apparent thickness of the immiscible layer is defined as the difference between the liquid level and the interface level.

* A sample will be collected, using a transparent Teflon bailer. Presence of the immiscible layer will be confirmed visually.

5.7.2 Soil, Rock, and Sediment Sampling. Samples of soil and rock from drill holes will be taken using flight augers, Shelby tubes, split spoon samplers, Denison samplers, or a core barrel. Undisturbed samples will be sealed in wax and disturbed samples will be placed in plastic or glass jars and shipped to SWD Lab. Disturbed samples will be either taken as discrete samples or as composites from the lower auger flights or throughout the length of the sample. All samples will be as representative of the strata as possible. All core not taken as samples will be placed in boxes, labelled by depth. Depth intervals at which core loss occurred and samples were collected will be noted on the geologic log and in the core boxes. Sample locations will also be logged in the field journal. The core will be photographed at a location approved by Carswell AFB. Carswell AFB will store all core samples taken that are not contaminated. Core that is contaminated will be disposed of in accordance with Section 5.11. Grab samples of soil and sediment will be collected using stainless steel coring tubes, augers, or other appropriate collection devices. Ditches and playas will be sampled by obtaining both grab and composite samples at discrete depths and depth ranges.

5.7.2.1 Chemical Testing. Soil, sediment, and rock samples will be analyzed for the parameters listed in Table 5-1. Samples will be placed in pre-cleaned glass jars with teflon-lined caps. The samples will be packed in ice-filled ice chests, and shipped to the laboratory by bus or overnight carrier to SWD Lab. QA/QC samples for soil and rock consist of equipment blanks and replicates as discussed in Section 5.10.

5.7.2.2 Physical Testing. Soil, sediment, and rock samples will be described in the field and tested for Atterberg limits, grain size distribution, moisture content, density, specific gravity, permeability, pH, and cation exchange capacity. Clay mineralogy will be determined on several samples. Soil samples will be classified using the Unified Soil Classification System. Density, permeability, and specific gravity require undisturbed samples. Samples will be shipped to SWD Lab or to a contract laboratory for testing. Replicates will be taken as needed for QA/QC purposes by splitting a sample into three portions or taking three grabs from the sampler. The two additional samples will consist of a QC sample to be tested by the same lab and a QA sample to be tested by SWD Lab. Methods for physical tests are given in Table B-3.

5.7.3 Surface Water Sampling. Water samples will be collected directly into the sampling bottle or by such sampling devices as a Kemmerer sampler or a plexiglass Van Dorn sampler. Surface water samples are anticipated at Playa 1, which contains water most of the year. Parameters to be tested are listed in Table 5-1.

5.8 Field Screening. Field screening techniques give an indication of the degree of contamination. These techniques are used to locate areas for more extensive exploration and sampling, to define the lower limits of sampling and testing in a borehole, and to determine safety hazards for worker protection and transport.

5.8.1 Organics.

5.8.1.1 Headspace Analysis. A headspace analysis tests the air in a sampling jar for volatile organics. A sample will be placed in a glass jar, which will be covered with foil, and warmed to a temperature of at least 90° F for one to two hours. At the end of the warming period, the vapor space in the jar will be tested with Draeger tubes. The temperature of the soil and the length of warming will be recorded. This test gives an indication of presence or absence of volatiles.

5.8.1.2. Field GC Analysis. A gas chromatograph will be set up in the field laboratory to screen selected samples for organics. Results of these analyses will be used to determine where samples for laboratory analysis are to be taken.

5.8.1.3 Soil Gas Surveys. Air-filled voids in the soil may contain compounds which volatilize from the groundwater below. A soil gas survey is a systematic sampling, analysis, and interpretation of the soil gas and what it represents. Sampling devices are placed in the ground on a grid to obtain samples of soil gas, which is analyzed either on site or in the laboratory. Soil gas surveys can detect contaminant plumes, the parent product, and the degree of weathering.

5.8.1.4 Air Monitoring for Worker Protection. Air monitoring with a photoionization detector, combustible gas meter, or flame ionization detector, will be used as discussed in the Site Specific Health and Safety Plan (SSHP).

5.8.2 Landfill Gas Quantification. The amount of explosive gas (primarily methane) is measured in a landfill by capturing the gas emitted over a known cross-sectional area and determining the percentage of the lower explosive limit with a combustible gas meter.

5.9 Decontamination.

5.9.1 Drilling Equipment. Drilling equipment (augers, bits, core barrels, rods, and tools) will be steam cleaned or hot water pressure cleaned prior to use in each boring. At each drill site, a decontamination station will be established in the contamination reduction corridor for the washing of drilling and sampling equipment. Waste washwater will be collected. Each member of the drilling crew will don a new pair of gloves before beginning each soil boring. The person taking the samples will wear disposable plastic gloves and will change them between each sampling interval. Used gloves will be bagged and disposed of in a manner which meets RCRA guidelines, as discussed in Section 5.11.

5.9.2 Well casing. All casing and screens used in monitoring well construction will remain in the factory-sealed containers until use. These materials will be placed on a clean, dry tarp or on blocks during assembly. If contact with the ground does occur, the affected sections will be cleaned with low sudsing soap and potable water.

5.9.3 Sampling Equipment. Bailers and other sampling equipment will be cleaned at the end of the work day. Enough clean sampling equipment will be taken to the field each day so that none needs to be reused in that day's sampling. The sampling equipment will be transported in sealed, clean containers, and care will be taken to avoid contamination. Sampling equipment will be washed with a non-phosphate detergent, tap water, distilled water, and hexane, in that order, allowed to air dry, and sealed back into clean containers. A cleaning seal will accompany each bailer with the following information: equipment identification number, date and time cleaned, and signature of the person who cleaned the equipment. The inclusion of the cleaning seal and numbering of the equipment allows for the tracking of any cleaning or cross contamination problems between samples. Purging equipment will be cleaned with distilled water and a brush. If the purging equipment is heavily contaminated, as determined by sight, smell, and air monitoring, it will be cleaned as described above. Each member of the sampling crew will don a new pair of gloves at each sampling location. The person who actually takes the samples will wear disposable plastic gloves and will change them between each sampling interval for each sampling site. Used gloves will be bagged and disposed of as discussed in Section 5.11.

5.10 Field QA/QC.

5.10.1 Chemical Samples. QA/QC samples for water, sediment, and soil will be used to verify that the sampling and analytical techniques are being performed properly. QC samples are taken in the field and analyzed with the field samples by the same laboratory. QA samples are analyzed by SWD Lab to check the performance of the contract laboratory. QC samples required for soils and water sampling include travel blanks, equipment blanks, and replicates. QA samples also include replicates. QA/QC samples are entered into the field journal along with their associated samples and are described below.

5.10.1.1 Travel Blanks. Travel blanks consist of American Society of Testing Materials (ASTM) Type II reagent water sealed into a sample vial in the field laboratory. The blank is not opened again until it is received in the laboratory. One travel blank will be prepared for each shipment of water samples containing volatiles, all of which are shipped in the same ice chest to the lab each day. Travel blanks measure cross contamination during shipment and contamination sources contacted during shipment. They are analyzed for volatiles.

5.10.1.2 Equipment Blanks. Equipment blanks for water or soil samples will consist of ASTM Type II water which has been poured over or through non-dedicated sampling equipment such as augers, knives, spoons, or bailers. They will be shipped in the ice chest with the associated samples from the site. Equipment blanks will be prepared and preserved in the same manner as a water sample. Equipment blanks measure the effectiveness of equipment decontamination. Equipment blanks are taken at a rate of 1 for every 20 samples and are analyzed for the same constituents as the associated soil or water samples.

5.10.1.3 Replicate Samples. Replicate samples or splits are extra samples as identical as possible to the original. They may consist of a composite, or as a series of grab samples from the same source. Every tenth sample is taken in triplicate. One of each set of these replicates will be sent to SWD Lab as an audit sample (QA sample) for the contract laboratory, and the other two samples will be sent to the analytical lab as a field sample and a QC sample, each with a unique sample number. In cases where only sufficient sample exists for a duplicate set, every fifth sample is a duplicate. This duplicate alternates as a QC and QA sample. Field tests will be done in duplicate.

5.10.2 <u>Samples for Physical Testing</u>. QA/QC on samples for physical testing consists of replicate samples as described in Section 5.10.1.3.

5.11 <u>Disposal of RI/FS Generated Wastes</u>. Waste will be derived from the RI/FS activities at Carswell. The activities that have the potential to generate waste are soil sampling and monitoring well installation, and groundwater sampling. The sampling results of previous investigations will be utilized to assist in determining the type of waste that may be generated. The RI/FS generated waste from soil sampling and well installation will be managed as a solid waste that has the potential to be considered hazardous waste. It will be contained in such a manner to ensure that the waste from each sampling location for each medium is kept separate from the other waste until the results of the sampling are received and an accurate determination of the status of the waste can be made. The Fort Worth District will be responsible for managing the waste generated during the investigation activities until it is turned over to the management and operating contractor for storage and disposal and manifesting, if needed. The waste will be managed such that all Federal and State regulations governing the disposal of hazardous waste (as defined in 40 CFR, Parts 260-265 and 268) and non-hazardous solid waste will be followed. If any of the waste is transported off site for disposal, the management and operating contractor and/or the DOE will be responsible for signing the manifest.

6.0 SAMPLE HANDLING AND TESTING.

6.1 Sample Numbering System. Sample numbers are assigned as follows:
CARss-hhhh-xaaa-bb

CARss refers to the site being investigated at Carswell AFB,
hhhh is the well or boring number, x describes the sample medium, where:

1 = groundwater
2 = soil or rock
3 = ditch sediment
4 = playa sediment
5 = surface water,

aaa is the sample number,
bb is a QA/QC modifier, when needed, where

QA = a QA sample (split for SWD Lab)
QC = a QC sample (split for contract lab)
TB = travel blank
EB = equipment blank.

6.2 Preparing Samples. A field laboratory will be established at Carswell AFB. This lab could either be a mobile lab or a trailer in a fixed location. The field laboratory will be used for reagent preparation, sample filtering, sample preservation, equipment decontamination and cleaning, labelling bottles, and doing paperwork. When samples are brought in from the field, they are preserved according to Table B.1. They are then placed in the ice chest in styrofoam inserts which have cutouts to accommodate the jars. The styrofoam prevents breakage. The ice chest is filled with ice and the chain of custody form and field data form are placed inside in a zip-lock plastic bag placed on top of the ice. The ice is double bagged if the samples are to be shipped by air. If the samples are to be shipped by bus, ice is placed directly over the samples to allow for maximum cooling. The ice chest is wrapped with nylon strapping and a seal is placed on the strapping. A separate ice chest is used for each set of samples. All of the volatile organics samples, however, are placed in one ice chest with a travel blank and a separate COC. The samples are then delivered to the bus station. Samples are always shipped on the day they are sampled.

6.3 Receiving Samples. After the ice chests are picked up from the bus station, the samples are logged in, the COC is signed, and the samples are checked for breakage or leakage. The temperature of the ice bath is checked.

If the temperature exceeds 4°C or if any other problems are noted, this information is recorded on the COC and the District office is notified of the problem. Samples are repackaged and shipped to contract laboratories using similar procedures as described in Section 6.2.

6.4 Laboratory Procedures. Laboratory analytical procedures come from the following sources: U. S. Environmental Protection Agency (SW 846 and EPA-600, refs. 13 and 11), Standard Methods (ref. 1). Analytical methods from these sources are given in Table B-2. Quantitation limits are given in Tables B-4 through B-6. Quantitation limits, however, are dependent on the concentration of the components in the matrix to be analyzed. Calibration of laboratory instruments will be performed according to manufacturer's recommendations.

7.0 SAMPLE INTEGRITY. The quality of analytical data is suspect if the integrity of the sample cannot be ensured. Integrity includes the procedures and written records which, when taken together, verify that the sample is as represented.

7.1 Security. Security involves procedures which ensure sample integrity. Security is required until final disposal of the sample after laboratory analysis is complete. Aspects of sample security are discussed below.

7.1.1 Security of the Well. Each well will have a locking cap and keys will be given out only to those who need them. Because Carswell AFB is not an open facility, access to the monitoring wells will be limited.

7.1.2 Security of the Sample in the Field. Samples, once taken, will be in the possession of the sampling crew or locked in the field laboratory. QA and QC samples will be taken, which, when analyzed, will also document the integrity of the sample.

7.1.3 Security of the Sample in the Lab. Samples will be stored in a secure area in the laboratory with limited access to authorized laboratory personnel. Upon receipt of the ice chests, laboratory personnel will check the temperature of the ice bath, the condition of the samples, and the accuracy of the accompanying paperwork.

7.2 Custody. Custody consists of formal records which document integrity. These records are described below.

7.2.1 Chain of Custody Form. The chain of custody form (COC) is a record which describes the sample, the date and method of sampling, and the analyses required. It has spaces for signatures of those receiving and relinquishing the samples. The form is normally signed by the sampler, the individual preparing the samples for shipment, and the receiving individual at the laboratory. A copy of this form is sent to the District office regularly. The original COC is returned to the Fort Worth District in the hard copy laboratory report, where it is placed on file. An example of this form is given in Appendix A.

7.2.2 Laboratory Traffic Report. Samples which are sent from SWD Lab to a contract lab are sent with this form. It is a laboratory chain of custody form which gives the sampling date, the analyses to be performed and the date the results are needed. Because various fractions of the sample might be sent to several contract labs, the original COC cannot be used. The traffic reports are also returned to the District in the hard copy laboratory reports.

7.2.3 Bill of Lading. A bill of lading (bus bill or airbill) documents receipt of the samples by the carrier. It is not possible for the carrier's representative to sign the COC since it is sealed in the ice chest. Bills of lading are kept on file in the District Office.

7.3 Sample Tracking and Identification. Other than the items listed in 7.2, there is additional documentation which demonstrate sample integrity. These are listed as follows:

7.3.1 Field Log Book. The field log book is a bound record, kept by the water sampling crew, in which sampling information is recorded. It is taken to the wells to record purging and sampling data, water levels, and other items of interest. It is used in the field lab to record preservation and preparation procedures for shipment. It is also used to record equipment calibration and decontamination of sampling equipment. In case of concurrent operations, sampling information will be transferred to the field log book in the field lab. The information for the COC and field data form comes from the field log book. The field log book is not the same as the field journal, which is kept by the Field Manager.

7.3.2 Field Data Form. The field data form transmits necessary information about the well to the lab. Field measurements such as pH, conductivity, and water levels as well as problems with the well or the sample are noted on this form. An example is shown in Appendix A.

7.3.3 Sample Labels. Labels on each jar contain the well or boring number, the sample number, preservation (if any), the analysis to be performed, and the sampler's signature. Examples are provided in Appendix A.

8.0 DATA REDUCTION, VALIDATION, AND REPORTING.

8.1 Analytical Data.

8.1.1 Field Data. Field data reduction will be performed in the Fort Worth District Office. Data validation in the field is determined primarily by making several readings (QC checks for reproducibility). Periodic QA oversight is also a part of the validation process. The field data is sent to the lab on the field data form and is returned to the District in the hard copy lab reports.

8.1.2 Laboratory Data. Laboratory data are reduced at the contract lab, which generates a laboratory report containing the analytical data and field and lab QC. SWD Lab performs a QA validation and generates a summary report, which is submitted to the HWM Section, where it is reviewed, then submitted to the project staff. A sample QA validation form is given in Appendix D. On this sample form, "laboratory contamination" will be retitled "representativeness" and shall include evaluation of blanks and chain of custody control. "QA/QC data comparison" will be retitled "Comparability" and will include comparisons of the Government's QA samples to the QC duplicates. Table B-10 outlines the items which will be evaluated when the data is evaluated. Laboratory deliverables include the following:

- analytical data, results of field and laboratory blanks, matrix spikes, and matrix spike duplicates, surrogate recoveries, and field splits, and COC forms;
- QA validation report;
- ASCII or dBase format data files.

Calibration and internal standards information, raw data, and all instrumentation graphs and traces will be available from the laboratory, if needed.

8.2 Technical Data. Technical data refers to data of several types, such as groundwater flow calculations, stratigraphic maps generated from geologic and geophysical field data, isopleth profiles of contaminants, and statistical models. Technical data will be reduced, validated, and reported by the project staff, and is subject to review by the HTW QA&IH Section. Data reduction involves the digitizing of plot data not already provided in graphical form, and creation of computer disk files containing all information related to the data forms listed above. Technical data reduction is discussed in detail in the Data Management Plan.

10.0 CORRECTIVE ACTION.

10.1 **Field Activities.** Field activities which are improper will be corrected as quickly as possible. The Field Manager will be responsible to see that corrective action is initiated and documented whenever the error has the potential to compromise the quality of the data being generated or whenever there is a possibility that the error might be repeated. Corrective action can also be initiated by personnel from the HWM Section during site visits. QA personnel will complete a trip report, which will be sent to the technical manager through Chief, Geotechnical Branch. This report will document problems and proposed corrective action. It will be a part of the permanent project files. QA personnel will also make recommendations to the field crews through the Field Manager who can give approval for immediate implementation.

10.2 **Field Data.** Corrective action for poor field data quality (as determined by replicate measurements or prior expectation) consists of remeasurement until successive readings agree within reasonable limits. Examples of frequently made measurements and limits to which they should agree include:

- pH - Measurements should agree within 0.02 pH units.
- conductivity - Measurements should agree within 2 units of the last significant digit.
- depth and water level measurements - Readings should agree within 0.01 foot.

If remeasurement is not successful, then instrument calibration and operation and the user's technique will be evaluated.

10.3 **Laboratory.** Laboratory corrective action is described in the analytical method for that analysis.

9.0 AUDITS. Audits, which are QA procedures designed to meet the data quality objectives discussed in Section 4, are of two basic types as discussed below. Table 9.1 gives the audit elements for the Carswell AFB investigation and their frequency of implementation.

9.1 System Audits. A systems audit is a qualitative evaluation of all components of a project to determine if each component is properly performed. Systems audits are generally performed at the outset of investigations and periodically during the life of a project. Systems audits for office and fieldwork will be performed by HWM Section, and system audits for laboratory work will be performed by the MRD Lab. These audits consist primarily of site inspections. Laboratory site inspection by MRD Lab is discussed in Section 3.4.3 and ER 1110-1-263 (ref. 8).

9.2 Performance Audits. Performance audits are quantitative evaluations of the components of a project. These consist of audit samples to be checked by MRD as a part of the laboratory validation process, QA replicates taken as a part of the sampling process and analyzed by SWD Lab, and laboratory QA procedures as specified by the analytical method.

TABLE 9-1 AUDIT ELEMENTS FOR CARSWELL AFB INVESTIGATIONS

Element	Performed By	Frequency
laboratory site inspection	MRD Lab	when laboratory is selected and as often as 18 months thereafter
field inspections	HWM Sec	monthly or more frequently at first; less frequently thereafter
technical data inspections	HWM Sec	as needed
laboratory check samples	MRD Lab	when laboratory is selected and as often as 18 months thereafter
analysis of field replicates	SWD Lab	every 10 samples
laboratory QA summary report	SWD Lab	one for each laboratory report

REFERENCES 130107

1. American Public Health Association, 1989, "Standard Methods for the Examination of Water and Wastewater", 17th Ed., APHA, Washington, DC.

2. American Society for Testing and Materials, 1984, Soil and Rock; Building Stones; Section 4, Construction, V04.08.

3. Jenkins, T.F., Miyares, P.H., and Walsh, M.E., November, 1988, "An Improved RP-HPLC Method for Determining Nitroaromatics and Nitramines in Water", USATHAMA report AMXTH-TE-CR-88020.

4. USATHAMA Method SM-01, RP-HPLC Method for Analysis of TNT, RDX, HMX, and 2,4-DNT in Munitions Wastewater.

5. USATHAMA Method SM-02, RP-HPLC Method for the Determination Explosive Residues in Soil.

6. U. S. Army Corps of Engineers, November, 1970, "Laboratory Soils Testing", EM-1110-2-1906.

7. U. S. Army Corps of Engineers, August, 1989, "Minimum Chemistry Data Reporting Requirements for DERP and Superfund HTW Projects", CEMRD-ED-GC Memorandum.

8. U. S. Army Corps of Engineers, January, 1990, "Chemical Data Quality Management for Hazardous Waste Remedial Activities", ER-1110-1-263.

9 . U. S. Department of Agriculture Soil Conservation Service, Soil Survey Investigation Report No. 1.

10. U. S. Department of Energy, Albuquerque Operations Office, Environment and Health Division; ER Program Group, May 1988, Standard Operating Procedures.

11. U. S. Environmental Protection Agency, March, 1983, "Methods for Chemical Analysis of Water and Wastes", EPA-600/4-79-020.

12. U. S. Environmental Protection Agency, September, 1986, "RCRA Ground Water Monitoring Technical" Enforcement Guidance Document.

13. U. S. Environmental Protection Agency, November, 1986, "Test Methods for Evaluating Solid Waste", SW 846, 3rd Ed.

14. U. S. Environmental Protection Agency, May, 1987, "Data Quality Objectives for Remedial Response Activities: Development Process", EPA 540/G-87/003.

15. U. S. Environmental Protection Agency, 1987, "Development of an RFI Work Plan and General Considerations for RCRA Facility Investigations", SW-87-001.

16. Willis, B. and Meyer, T.F., "Explosives Analysis by High Performance Liquid Chromatography" (variant of USATHAMA method SM-01 for water).

130108

ILLEGIBLE DOCUMENT

THE FOLLOWING DOCUMENT(S) IS ILLEGIBLE OR OF POOR LEGIBILITY IN THE ORIGINAL THIS IS THE BEST COPY AVAILABLE.

100109

APPENDIX A

FORMS USED IN FIELD SAMPLING ACTIVITIES

TABLE OF CONTENTS

MIPR NO.________	CHEST NO.________	TEMPERATURE _____ °C	PAGE ____ OF ____

CHAIN OF CUSTODY RECORD
CARSWELL AIR FORCE BASE RI/FS

US Army Corps of Engineers
Fort Worth District, Fort Worth, Texas

Location________	Date________	Time________
Site________	Commercial Lab________	Lab Location________
Sampler________	USACE Proj Engr________	Engr's Phone No.________

SAMPLE INFORMATION

CUSTODY RECORD

WATER SAMPLE FIELD DATA FORM

100111

PROJECT: ______________________ DATE: __________

SITE: ______________________ TYPE OF SAMPLE: __________

WELL NO: ______________ LOCATION: ______________

CSG DIAM ______________ CSG TYPE: ______________

RISER ELEV. ______________________

DEPTH TO WATER AT TIME OF PURGING: __________ TIME: __________

RATE OF RECHARGE: ______________________

DEPTH TO WATER AT TIME OF SAMPLING: __________ TIME: __________

WATER TABLE: __________ MEASURING DEVICE: __________

pH: ________ ________ TIME: __________ TYPE: __________

pH: ________ ________

CONDUCTIVITY, umhos/cm TIME: __________ TYPE: __________

________ ________ TEMPERATURE: __________

________ ________ TURBIDITY: __________

CHEST# __________ C/SEAL# __________ BUS BILL# __________

CHEST# __________ C/SEAL# __________ BUS BILL# __________

NOTES CONCERNING CONDITION OF WELL, ODOR, COLOR, AND PROBLEMS

____

____

____

____

____

____

____

____

SAMPLE COLLECTOR: ______________________

SOIL SAMPLE FIELD DATA FORM

100112

Location____________________________________ Date__________

Site__________________________________ Sample No.____________

Weather Conditions____

____

Excavation Conditions____

____

Sampling Depth________________ Start/End Times________________

Sample Containers Collected:		QA/QC Samples Collected:	
VOAs	_____	VOAs	_____
Total metals	_____	Total metals	_____
TCLP metals	_____	TCLP metals	_____
Total & TCLP metals	_____	Total & TCLP metals	_____
Pesticides	_____	Pesticides	_____
SVOAs	_____	SVOAs	_____
____________	_____	____________	_____
____________	_____	____________	_____

Cooler No.________________

Remarks/Comments____

____

____

____

____

____

SAMPLE COLLECTOR: ____________________________________

SAMPLE JAR LABEL

CARSWELL AFB RI/FS
DATE__________ TIME SAMPLED________
SAMPLE NO.____________________
PRESERVATIVE__________ TYPE________
____________________ (Parameter)
SIGNATURE____________________

130114

1. PROJECT

2. LOCATION (Coordinates or Station): SEE LAYOUT

3. DRILLING AGENCY: USCE

4. HOLE NO. (As shown on drawing title and file number): 345-30

5. NAME OF DRILLER:

6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.

7. THICKNESS OF OVERBURDEN: 8.6' ±

8. DEPTH DRILLED INTO ROCK: 25.5' ±

9. TOTAL DEPTH OF HOLE: 34.1'

10. SIZE AND TYPE OF BIT: 3" SHELBY - 2" SPLIT SPOON

11. DATUM FOR ELEVATION SHOWN (TBM or MSL):

12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500

13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED — UNDISTURBED —

14. TOTAL NUMBER CORE BOXES: N/A

15. ELEVATION GROUND WATER: SEE REMARKS COLUMN

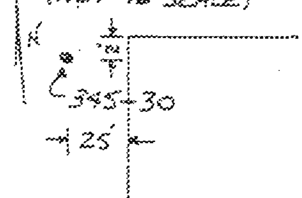
16. DATE HOLE: STARTED 11 AUG. 92 COMPLETED 12 AUG. 92

17. ELEVATION TOP OF HOLE:

18. TOTAL CORE RECOVERY FOR BORING: N/A %

19. SIGNATURE OF INSPECTOR:

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
	0.0		0.0' To 1.1' CONCRETE 1.1' To 1.4' GRAVEL BASE 1.4' To 2.7' SAND FILL: FINE TO COARSE; LOOSE; DAMP; LIGHT BROWN-YELLOWISH BROWN; WITH SCATTERED FINE GRAVEL 2.7' To 3.4' CLAY FILL: MEDIUM-HIGH PLASTICITY; RED; STIFF; DAMP-MOIST		ROCK-BIT 3" SHELBY	1. WATER LEVEL: NOTE: SOME FREE WATER IN BORING AT 11.0'± (CASED OFF); NEXT FREE WATER AT 16.0'±; INCREASE IN FREE WATER AT 29.0'; NOTE: LEVEL OVERNIGHT WAS 4.74' ON 12 AUG. AT 0800 HRS.
	8.6		3.4' To 3.8' CLAY FILL: MEDIUM PLASTICITY; GRAYISH BROWN; MEDIUM-STIFF; MOIST 3.8' To 5.6' SILT: MEDIUM PLASTICITY; GRAY; STIFF; DAMP-MOIST; CLAYEY; WITH TRACE OF SAND 5.6' To 8.6'± CLAY: MEDIUM-HIGH PLASTICITY; RED & LIGHT GRAY; STIFF-VERY STIFF; DAMP-MOIST		S-1 S-2 S-5	2. SOIL SAMPLES: (FOR LAB. ANALYSIS) S-1: 7.6' - 8.6' S-2: 8.6' - 9.6' S-3: 31.6' - 32.6' S-4: 32.6' - 33.6' S-5: 13.1' - 14.6' SPLIT/DUPLICATE: S-3"QA": 31.6' - 32.6' 345-30A: 31.6' - 32.6' NOTE: A RINSATE WAS TAKEN JUST PRIOR TO TAKING "QA" SAMPLE. NOTE: EACH SAMPLE CONSISTED OF (1) ONE-HALF LITER JAR & (2) 125 ML. JARS. NOTE: S-1 (BOTTOM OF OVERBURDEN SAMPLE) CONSISTED OF AN ADDITIONAL ONE-HALF LITER JAR.
	20		8.6'± To 32.6'± CLAY SHALE: BADLY WEATHERED DOWN TO SLIGHTLY WEATHERED FROM 24.0'±; YELLOWISH BROWN WITH LIGHT GRAY WITH SOME DARK GRAY BANDING FROM 24.0'±; SOFT-VERY SOFT; DAMP; VERY CLAYEY TO 10.0'±; MODERATELY SILTY TO SILTY FROM 10.0'±; WITH CARBON STAINS TO 11.0'±; WITH FERRUGINOUS STAINS & CONCRETIONS; WITH SCATTERED WELL DEVELOPED TIGHT FRACTURES & OCCASIONAL GYPSUM LINED FRACTURE FROM 24.0'±		2" DRIVE SAMPLE	3. WATER SAMPLES: NOTE: A "GRAB" SAMPLE OF WATER [(3) 40 ML. VIALS] WAS TAKEN ON 12 AUG. 92 AT 1335 HRS. WITH LEVEL AT 25.45'. SAMPLE WAS SHIPPED TO LAB. WITH TRAVEL BLANK.
	32.6		32.6'± To 34.1' T.D. CLAY SHALE: ESSENTIALLY UNWEATHERED; BROWN & BLUE GRAY; SOFT (MORE INDURATED THAN ABOVE); DAMP; WITH SCATTERED THIN LAMINATIONS OF FINE SILTY SAND	QA/QC	S-3 S-4	4. BORING LOCATION: (NOT TO SCALE)
	34.1		T.D. 34.1'			
	40					



ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT | HOLE NO.

100115

2. LOCATION (Coordinates or Station)	10. SIZE AND TYPE OF BIT
	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number) 345-30	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	16. DATE HOLE — STARTED 11 AUG. 92 — COMPLETED 12 AUG. 92
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR

SAFETY PROCEDURES:

NOTE: THE WORK AREA BEHIND THE DRILL RIG IN THE "KNEE-TO-CHIN" ZONE WAS MONITORED PERIODICALLY WITH THE HNU ANALYZER & READINGS RANGED FROM THE BACKGROUND READING OF 1.5 PPM. TO 2.0 PPM.

NOTE: ALL FIELD ACTIVITIES WERE IN ACCORDANCE WITH THE SAFETY PROGRAM PLAN.

NOTE: ALL SAMPLE HANDLING WAS IN ACCORDANCE WITH ER 1110-1-263.

6A. HNU READINGS & DEPTHS:

	0.5 PPM (10.1'-11.6')
PEAKED @ 7.0 -	2.7 PPM (13.1'-14.6')
	1.0 PPM (14.6'-16.1')
	1.0 PPM (16.1'-17.6')
PEAKED @ 4.0 -	1.5 PPM (17.6'-19.1')
" "	0.9 PPM (19.1'-20.6')
" 4.5 -	1.5 PPM (20.6'-22.1')
" 5.0 -	1.5 PPM (22.1'-23.6')
" 6.5 -	1.8 PPM (23.6'-25.1')
" 6.8 -	2.5 PPM (25.1'-26.6')
" 3.0 -	0.5 PPM (26.6'-28.1')
	0.5 PPM (28.1'-29.6')
	0.4 PPM (29.6'-31.1')
	0.4 PPM (31.1'-32.6')
	0.0 PPM (32.6'-34.1')

NOTE: READINGS ARE ABOVE THE BACKGROUND READING OF 1.5 PPM.

5. DRILLING:

9 7/8" ROCKBIT: 0.0' - 1.1'

3" STAINLESS STEEL SHELBY TUBE: 1.1' - 13.1'

NOTE: LOST SAMPLE FROM 11.6'-13.1' DUE TO ABUNDANT FREE WATER OVERNIGHT. AUGERED BORING TO 13.1' & SET 8" STEEL CASING TO 13.1'

3" STAINLESS STEEL SHELBY TUBE: 13.1' - 14.6'

NOTE: SHELBY REFUSAL AT 14.6'

2" SPLIT SPOON DRIVE SAMPLER: 14.6' - 34.1'

6. FIELD SCREENING:

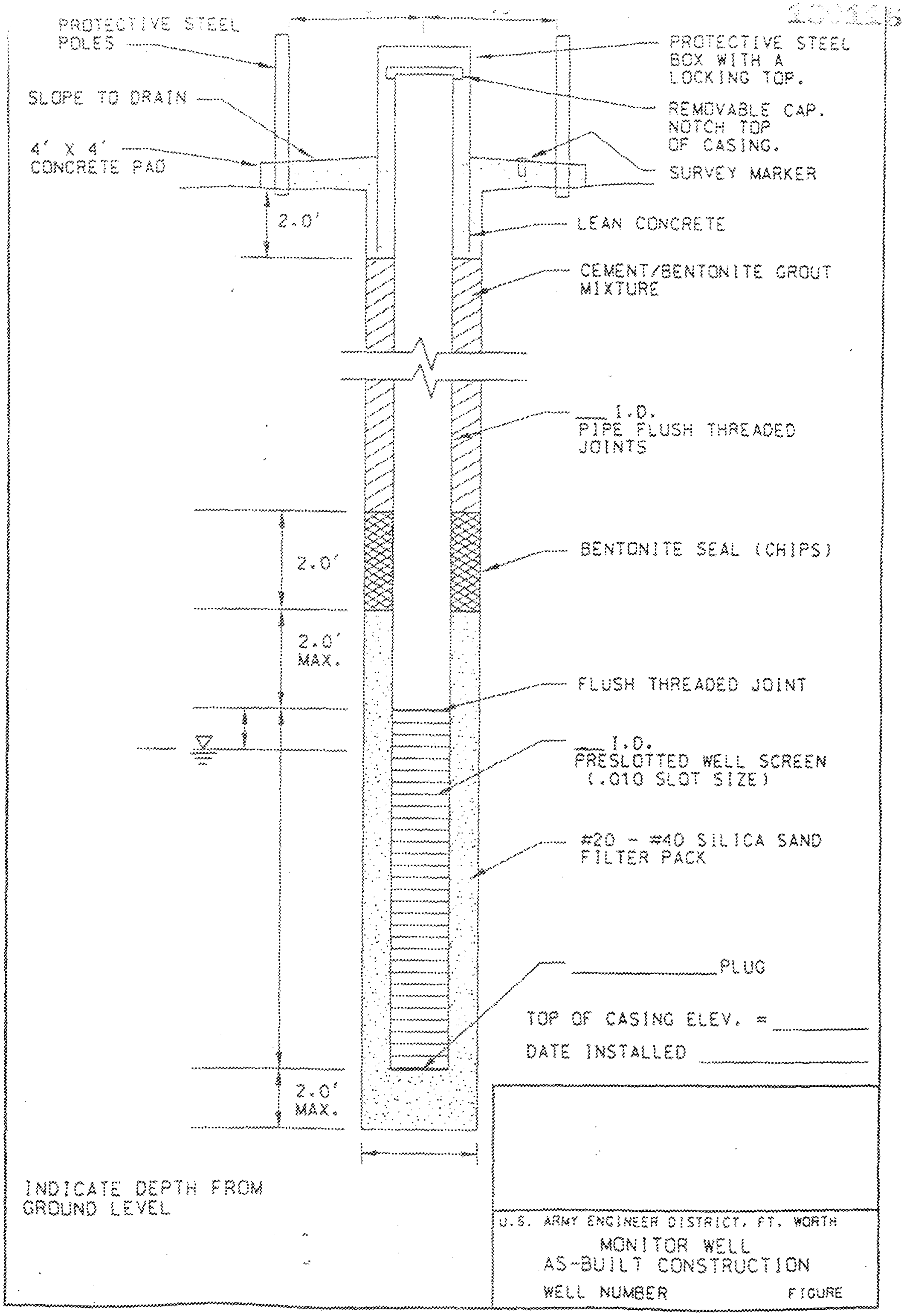
NOTE: EACH SAMPLE WAS EXTRUDED & CHECKED WITH A PID (HNU ANALYZER) FOR CONTAMINATION. SAMPLES FROM 10.1'-32.6 SHOWED A RESPONSE ABOVE THE BACKGROUND READING OF 1.5 PPM. REFER TO 6A. IN LEFT COLUMN FOR READINGS & DEPTHS.

NOTE: ALL SAMPLES, WITH THE EXCEPTION OF THE FIVE FIELD SAMPLES & QA/QC SAMPLES SHIPPED FOR ANALYSIS, WERE CONTAINERIZED ALONG WITH EXCESS SOIL CUTTINGS. NOTE: AN 11.7 eV LAMP WAS USED WITH THE HNU ANALYZER WITH A SPAN SETTING OF 5.0.

7. NOTE: BORING WAS BACKFILLED AS REQUESTED.

8. NOTE: NO UNUSUAL ODORS WERE DETECTED FROM SOIL SAMPLES.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT: HOLE NO. 345-30



PROTECTIVE STEEL POLES
SLOPE TO DRAIN
4' X 4' CONCRETE PAD
2.0'
PROTECTIVE STEEL BOX WITH A LOCKING TOP.
REMOVABLE CAP. NOTCH TOP OF CASING.
SURVEY MARKER
LEAN CONCRETE
CEMENT/BENTONITE GROUT MIXTURE
___ I.D. PIPE FLUSH THREADED JOINTS
BENTONITE SEAL (CHIPS)
2.0'
2.0' MAX.
FLUSH THREADED JOINT
___ I.D. PRESLOTTED WELL SCREEN (.010 SLOT SIZE)
#20 - #40 SILICA SAND FILTER PACK
__________ PLUG
TOP OF CASING ELEV. = __________
DATE INSTALLED __________
2.0' MAX.
INDICATE DEPTH FROM GROUND LEVEL
U.S. ARMY ENGINEER DISTRICT, FT. WORTH
MONITOR WELL
AS-BUILT CONSTRUCTION
WELL NUMBER
FIGURE

(SAMPLE FORMAT)

CERTIFICATION OF MONITOR WELL ________ 130117

____
(Location of Well)

CARSWELL AIR FORCE BASE, TEXAS

This certification is accompanied by the boring log, survey information, and as-built contruction details.

This is to certify that installation of the following facility components authorized or required by the Texas Water Commission for the Carswell Air Force Base RI/FS on ____________ (date) has been completed, and that construction of said components has been performed in accordance with and in compliance with the design and construction specifications and state regulations.

Description: (Sample) The bentonite seal for this well is 1.6 feet thick because the top of the seal is two feet below the surface. Two feet of concrete was placed above the bentonite seal per direction of the RI/FS. The well has a 4" ID stainless steel casing and screen. The screen length is 19.5 feet and monitors the uppermost portion of the uppermost "aquifer" at the site. For additional information see the accompanying information, as referenced above.

Signature ________________________________ Date ____________

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APPENDIX B

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TABLE OF CONTENTS

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TABLE B-1 SAMPLE CONTAINERS, PRESERVATION, AND PREPARATION FOR WATER SAMPLES

PARAMETER	SIZE AND TYPE OF CONTAINER	# OF CONTAINERS	ICE	METHOD OF PRESERVATION
volatiles	40 ml glass vial	3	Y	no head space
semivolatiles	liter amber glass	2	Y	no head space, air bubbles, or agitation
pH	½ pint glass	1	N	field test
conductivity	½ pint glass	1	N	field test
temperature	½ pint glass	1	N	field test
common anions	liter glass	1	Y	
cyanide	liter plastic	1	Y	1 N NaOH to pH >12
metals	liter plastic	1	Y	nitric acid to pH <2
hexavalent Cr	liter plastic	1	Y	
alkalinity, carbonate, bicarbonate, total hardness, TDS, TSS	liter plastic	1	Y	
TRPH	liter amber glass	3	Y	hydrochloric acid to pH <2
nitrate/nitrite	liter plastic or glass	1	Y	sulfuric acid to pH <2

TABLE B-2 MAXIMUM HOLDING TIMES AND ANALYTICAL METHODS IN SOIL AND WATER 130121

PARAMETER	EXTRACTION	ANALYSIS	REFERENCE	METHOD #
Volatiles	-	14 days		
basic scan			SW-846	8240
TCLP			SW-846	1311/8240
additional compounds				
tetrahydrofuran			SW-846	8015
4,4'-dimethylforamide			SW-846	8015
methanol			SW-846	8015
ethyl acetate			SW-846	8015
isopropanol			SW-846	8015
propanol			SW-846	8015
dimethylsulfoxide			SW-846	8000
MTBE			SW-846	8020
Semivolatiles				
basic scan			SW-846	8270
TCLP			SW-846	1311/8270
in water	7 days	40 days		
in soil	14 days	40 days		
additional compounds			SW-846	modified 8270
4,4'-methylene bis o-chloroaniline)				
TRPH		28 days	EPA-600	418.1
Metals				
arsenic	-	6 months	SW-846	7060
mercury in soil	-	28 days	SW-846	7470
mercury in water		28 days	SW-846	7471
selenium	-	6 months	SW-846	7740
hexavalent chromium	-	24 hours	SW-846	7196
others	-	6 months	SW-846	6010
TCLP			SW-846	1311/6010 etc.
Common Anions	-			
chloride		28 days	SW-846	9250
phosphate		28 days	EPA-600	365.2
fluoride		28 days	EPA-600	340.2
sulfate		28 days	SW-846	9038
sulfite		28 days	EPA-600	377.1
nitrate/nitrite		14 days	EPA-600	353.2
Cyanide	-	14 days	EPA-600	335.2

TABLE B-2 MAXIMUM HOLDING TIMES AND ANALYTICAL METHODS IN SOIL AND WATER (cont)

130122

PARAMETER	EXTRACTION	ANALYSIS	REFERENCE	METHOD #
Alkalinity, incl. carbonate and bicarbonate		14 days	EPA-600	310.1
total phosphorus		48 hours	EPA-600	365.4
Total dissolved solids		7 days	EPA-600	160.1
Total suspended solids		7 days	EPA-600	160.2
pH	-	immediate		
Conductivity	-	immediate		
Temperature		immediate		

* Different methods exist for each RE. See discussion in Section 6.4.

STND	reference 1	EPA-600	reference 11
SW-846	reference 13		

100123

TABLE B-3 METHOD SOURCE FOR PHYSICAL TESTS

TEST	METHOD SOURCE
Clay mineralogy	ASTM D4647
Grain size	ASTM D421, D422, D1140
Atterberg limits	ASTM D4318
Specific gravity	ASTM D854
Triaxial permeability	EM-1110-2-1906
Moisture content	ASTM D2216
Density	ASTM D2937
Cation exchange capacity	AGRI Method 5A

ASTM reference 2
AGRI reference 9
EM reference 7

TABLE B-4 REQUIRED QUANTITATION LIMITS FOR VOLATILE ANALYSES IN SOIL AND WATER

100124

PARAMETER	WATER (ug/l)	LOW-LEVEL SOIL/SEDIMENT (ug/kg)	PROCEDURE
Chloromethane	10	10	basic 8240 scan
Bromomethane	10	10	"
Vinyl chloride	10	10	"
Chloroethane	10	10	"
Methylene chloride	5	5	"
Acetone	10	10	"
Carbon disulfide	5	5	"
1,1-dichloroethane	5	5	"
1,1-dichloroethene	5	5	"
cis-1,2-dichloroethene	5	5	"
trans-1,2-dichloroethene	5	5	"
Chloroform	5	5	"
1,2-dichloroethane	5	5	"
2-butanone (MEK)	10	10	"
1,1,1-trichloroethane	5	5	"
Carbon tetrachloride	5	5	"
Vinyl acetate	10	5	"
Bromodichloromethane	5	5	"
1,2-dichloropropane	5	5	"
Trichloroethene	5	5	"
Dibromochloromethane	5	5	"
1,1,2-trichloroethane	5	5	"
Benzene	5	5	"
trans-1,3-dichloropropene	5	5	"
4-methyl-2-pentanone	10	10	"
2-hexanone	10	10	"
Tetrachloroethene	5	5	"
Toluene	5	5	"
1,1,2,2-tetrachloroethane	5	5	"
Chlorobenzene	5	5	"
Ethylbenzene	5	5	"
Styrene	5	5	"
Xylenes (total)	5	5	"
Acrolein	?	?	"
Acrylonitrile	10	10	"
Dibromomethane	5	5	"
Dichlorodifluoromethane	5	5	"
1,4-dichloro-2-butene	10	10	"
Ethyl methacrylate	5	5	"
1,2,3-trichloropropane	5	5	"
Dichloromethane	5	5	"
Iodomethane	10	10	"
Trichlorofluoromethane	5	5	"

TABLE B-4 (cont) REQUIRED QUANTITATION LIMITS FOR VOLATILE ANALYSES IN SOIL AND WATER 100125

PARAMETER	WATER (ug/l)	LOW-LEVEL SOIL/SEDIMENT (ug/kg)	PROCEDURE
Tetrahydrofuran	100	100	additional compound
4,4-dimethylforamide	100	100	"
Methanol	50	50	"
Ethyl acetate	50	50	"
Isopropanol	50	50	"
Propanol	50	50	"
Dimethylsulfoxide	100	100	"

Medium soil/sediment quantitation limits are equal to 125 times the low soil/sediment quantitation limits.

TABLE B-5 REQUIRED QUANTITATION LIMITS FOR SEMIVOLATILE ANALYSIS IN SOIL AND WATER

PARAMETER	WATER (ug/l)	LOW LEVEL SOIL/SEDIMENT (ug/kg)	PROCEDURE
Phenol	10	330	basic 8270 scan
Bis(2-chloroethyl) ether	10	330	"
2-chlorophenol	10	330	"
1,3-dichlorobenzene	10	330	"
1,4-dichlorobenzene	10	330	"
Benzyl alcohol	10	330	"
1,2-dichlorobenzene	10	330	"
2-methylphenol	10	330	"
Bis(2-chloroisopropyl) ether	10	330	"
4-methylphenol	10	330	"
N-nitrosodi-n-propylamine	46	1600	"
Hexachloroethane	10	330	"
Nitrobenzene	10	330	"
Isophorone	10	330	"
2-nitrophenol	10	330	"
2,4-dimethylphenol	10	330	"
Benzoic acid	50	1600	"
Bis(2-chloroethoxy) methane	10	330	"
2,4-dichlorophenol	10	330	"
1,2,4-trichlorobenzene	10	330	"
Naphthalene	10	330	"
4-chloroaniline	10	330	"
Hexachloro-1,3-butadiene	10	330	"
4-chloro-3-methylphenol (para-chloro-meta-cresol)	10	330	"
2-methylnaphthalene	10	330	"
Hexachlorocyclopentadiene	10	330	"
2,4,6-trichlorophenol	10	330	"
2,4,5-trichlorophenol	50	1600	"
2-chloronaphthalene	10	330	"
2-nitroaniline	50	1600	"
Dimethyl phthalate	10	330	"
Acenaphthylene	10	330	"
2,6-dinitrotoluene	10	330	"
3-nitroaniline	50	1600	"
Acenaphthene	10	330	"
2,4-dinitrophenol	50	1600	"
4-nitrophenol	50	1600	"
Dibenzofuran	10	330	"
2,4-dinitrotoluene	10	330	"
Diethyl phthalate	10	330	"
4-chlorophenyl phenyl ether	10	330	"
Fluorene	10	330	"

TABLE B-5 (cont) REQUIRED QUANTITATION LIMITS FOR SEMIVOLATILE ANALYSES IN SOIL AND WATER

PARAMETER	WATER (ug/l)	LOW LEVEL SOIL/SEDIMENT (ug/kg)	PROCEDURE
4-nitroaniline	50	1600	basic scan
4,6-dinitro-2-methylphenol	50	1600	"
N-nitrosodiphenylamine	10	330	"
4-bromophenyl phenyl ether	10	330	"
Hexachlorobenzene	10	330	"
Pentachlorophenol	50	1600	"
Phenanthrene	10	330	"
Anthracene	10	330	"
Di-n-butyl phthalate	10	330	"
Fluoranthene	10	330	"
Pyrene	10	330	"
Butyl benzyl phthalate	10	330	"
3,3'-dichlorobenzidine	20	660	"
Benzo(a)anthracene	10	330	"
Chrysene	10	330	"
Bis(2-ethylhexyl)phthalate	10	330	"
Di-n-octyl phthalate	10	330	"
Benzo(b)fluoranthene	10	330	"
Benzo(k)fluoranthene	10	330	"
Benzo(a)pyrene	10	330	"
Indeno(1,2,3-cd)pyrene	10	330	"
Dibenz(a,h)anthracene	10	330	"
Benzo(g,h,i)perylene	10	330	"
1-chloroanaphthalene	10	660	"
3-methylphenol	10	330	"
diphenylamine	20	1000	"
1,2-diphenylhydrazine	50	1600	"
4,4'-methylene bis o-chloroaniline)	20	1300	additional compound

Medium soil/sediment quantitation limits are 60 times the low soil/sediment quantitation limits.

TABLE B-6 REQUIRED QUANTITATION LIMITS FOR INORGANIC AND OTHER ANALYSES IN SOIL AND WATER

PARAMETER		WATER (mg/l)	SOIL/SEDIMENT (mg/kg)
		metals	
Arsenic	(As)	0.01	2
Barium	(Ba)	0.2	40
Cadmium	(Cd)	0.005	1
Chromium	(Cr)	0.01	2
Lead	(Pb)	0.005	1
Mercury	(Hg)	0.0002	0.1
Selenium	(Se)	0.005	1
Silver	(Ag)	0.01	2
Beryllium	(Be)	0.005	1
Calcium	(Ca)	0.01	2
Iron	(Fe)	0.3	60
Magnesium	(Mg)	0.03	6
Manganese	(Mn)	0.05	2
Potassium	(K)	0.1	5
Sodium	(Na)	0.5	100
Zinc	(Zn)	0.02	10
		common anions	
Chloride		1	
Fluoride		0.1	
Sulfate		1	1
Sulfite		2	2
Phosphate, total as P		0.05	
Nitrate/nitrite		0.1	0.1
		limnological parameters	
Total dissolved solids		10	
Total suspended solids		10	
Phosphorus, total		0.05	
Cyanide, total and amenable		0.02	1
Carbonate		10	
Bicarbonate		10	
Total hardness		10	
Alkalinity		10	100
TRPH			

TABLE B-7 VALIDATION REPORT CHECK SHEET

ITEM	DQO*	PARAMETERS	FREQUENCY	ACCEPTABLE RESULTS
ANALYTICAL PARAMETER				
analytical method	C	all	each analysis	as specified on COC or Table B-2
holding time	P,A,R	all	each analysis	see Table B-2
quantitation limit	P,A,R	all	each analysis	see tables B-4 to B-9
matrix spike	A	all	1/batch or 5%	see SW-846
matrix spike dup	P	all	1/batch or 5%	see SW-8468
relative % difference	P	all	1/batch or 5%	see SW-8468
method blank	R	all	representative	clean
surrogate recovery	A	organics	each analysis	see SW-846
QC DUPLICATE (SAME LAB)	P	all	10% or 1/batch	water, ± 100% soil, ± 400%
QA DUPLICATE (OTHER LAB)	C	all	10% or 1/batch	water, ± 100% soil, ± 400%
TRIP BLANK	R	volatiles	1 per ice chest with volatiles	clean
EQUIPMENT BLANK	R	all	5%	clean
CHAIN OF CUSTODY FORM	R		1 per container	
filled out correctly				no missing or incorrect info see Table B-1
signatures				no lapses in custody
FIELD DATA FORM	R		1 per sample/well	
filled out correctly				no missing or incorrect info
purge and sampling time				< 24 hr lapse

* Data Quality Objective: P= precision, A = accuracy, R = representiveness, C = comparability

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(SAMPLE FORMAT)

________ LAB NO.

DEPARTMENT OF THE ARMY
________________ DIVISION, CORPS OF ENGINEERS
DIVISION LABORATORY

__________, ________, __________
(city) (state) (zip)

Subject: Chemical Quality Assurance Report

Project: ________________
Intended Use: ________________
Source of Material: ________________

Submitted by: ________________
Date Sampled: ____________, Date Received: ________

Method of Test or Specification: See Attached Tables 1 - X

References: ________________

-- REMARKS --

1. CONTRACTOR DATA EVALUATION: (General comments)

   a. ACCURACY:

   b. PRECISION:

   c. LABORATORY CONTAMINATION

2. QA/QC DATA COMPARISON:

3. OTHER PROBLEMS:

4. CORRECTIVE ACTION:

Submitted by:

Director, ________________ Laboratory

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ALTERNATIVES EVALUATION REPORT

1.0 Applicable or Relevant and Appropriate Requirements (ARARs).

1.1 Introduction. The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980 (Public Law 96-510) is the basis on which this section is prepared. Section 121(d)(2)(A) of CERCLA, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986 (Public Law 99-499), states that any remedial actions selected under CERCLA must comply with all legally applicable or relevant and appropriate requirements (ARARs) of any standard, requirement, criteria, or limitation under any Federal or consistently-enforced State environmental law. Where these laws conflict, the more stringent ARAR must be met.

1.2 Relationship to Alternatives Evaluation Report. All soil and water analyses will be compared to available regulatory criteria which include maximum contaminant levels (MCLs) and maximum contaminant level guidelines (MCLGs). Any applicable State water quality criteria will also be used. This information will be used to assess the applicability of preliminary technologies, and to determine whether an alternative remedial action can meet or exceed the ARARs. The ARARs are also useful in defining data sufficiency and developing an approach for the public health evaluation task. These activities will involve close interaction with regulatory agencdies in order to agree on criteria and methods.

1.3 Definitions and Types of ARARs.

1.3.1 Definitions. A requirement under other environmental laws may be either "applicable" or "relevant and appropriate", but not both. Identification of ARARs must be done on a site-specific basis and involves a two-part analysis: first, a determination whether a given requirement is applicable; then, if it is not applicable, a determination whether it is nevertheless both relevant and appropriate.

1.3.1.1 Applicable requirements. Cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site.

1.3.1.2 Relevant and appropriate requirements. Cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.

1.3.1.3 To-Be-Considered materials (TBCs). Non-promulgated advisories or guidance issued by Federal or State government that are not legally binding and do not have the status of potential ARARs. However, in many circumstances, TBCs will be considered along with ARARs as part of the site risk assessment and may be used in determining the necessary level of cleanup for protection of health or the environment.

1.3.2 Types. There are several different types of requirements with which CERCLA actions may have to comply. The classification of types of ARARs given in this section are not definitive, as some requirements may not fall distinctly into the specified categories of this system.

1.3.2.1 Chemical-specific. Requirements that are usually health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment. The list of chemical-specific ARARs is included as Table C-1.

1.3.2.2 <u>Action-specific</u>. Requirements that are usually technology- or activity-based requirements or limitations on actions taken with respect to hazardous waste. The list of action-specific ARARs is included as Table C-2.

1.3.2.3 <u>Location-specific</u>. Requirements that are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they occur in special locations. The list of location-specific ARARs is included as Table C-3.

TABLE C-1

CHEMICAL-SPECIFIC ARARs

Reference	Description
FEDERAL	
Safe Drinking Water Act (40 USC Section 300)	
National Primary Drinking Water Standards (40 CFR Part 141)	Health-based standards for public water systems (Maximum Contaminant Levels - MCLs)
Clean Air Act (42 USC Section 7401-7642)	
National Primary and Secondary Ambient Air Quality Standards (NAAQS) (40 CFR Part 50)	Standards for ambient air quality to protect public health and welfare
National Emission Standards for Hazardous Air Pollutants (NESHAPs) (40 CFR Part 61)	Emission standards for toxic or hazardous air pollutants for stationary facilities
EPA Test Procedures for the Analysis of Pollutants (40 CFR Part 61)	Test procedures for the analysis of pollutants
STATE	
Texas Water Commission, Water Hygiene Division (31 TAC Chapter 290)	Drinking water standards governing drinking water quality and reporting requirements for public water supply systems
Texas Water Commission (TWC) (31 TAC Chapter 307)	Texas surface water quality standards
Texas Groundwater Protection Bill (HB 1458, Section 1, Chapter 26, Water Code, Subchapter J)	Protection of present and future groundwater supplies
Texas Water Code	Requirements for discharge of waste into or adjacent to waters in the state
Texas Water Well Drillers Board (31 TAC Chapter 287)	Procedures and standards for reporting, drilling, completion, and plugging water wells; licensing procedures
Texas Air Pollution Regulations (31 TAC Chapters 101, 111, 112, 113, and 115)	Regulations and standards for air emissions
Industrial Solid Waste and Municipal requirements Hazardous Waste Rules (31 TAC Chapter 335)	Solid waste notification and classification
TBCs	
EPA Office of Solid Waste and Emergency Response (OSWER) Directive 9347.3-06FS	Treatment levels for contaminated soils and sediments
EPA OSWER Directive 9355.02	MCLs for contaminants
MCL Goals (MCLGs) (Public Law 99-339, 100 Statute 642, 1986)	Drinking water quality goals set at levels of no known or anticipated adverse health effects, with an adequate margin of safety
Federal Ambient Water Quality Criteria (FAWQC)	Protection of aquatic organisms and human health from contaminants in sediments

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TABLE C-2

ACTION-SPECIFIC ARARs

Reference	Description
FEDERAL	
Resource Conservation and Recovery Act (RCRA) of 1976 (40 CFR Part 264) Amended by the Hazardous and Solid Waste Amendments of 1984 (42 USC Sections 6901-6987)	
Criteria for Classification of Solid Waste Disposal Facilities and Practices (40 CFR Part 257)	Specify design, groundwater, monitoring, closure and post-closure care for specific types of facilities and specifies wastes acceptable for land disposal
40 CFR Parts 264.228, 264.258, 264.310 and 264.117	Requirements for design of capping of surface impoundments, waste piles and landfills. These address stabilization of waste before capping, use of property after capping, runon/runoff prevention, and maintenance of surveyed benchmarks
40 CFR Parts 264.110-120 Subpart G and 264.11	Clean closure standards for land-based units. Elimination of postclosure escape of contaminants
40 CFR Parts 264.111, 178, 197, and 258	Closure performance standards which may apply to surface impoundments and contaminated soils
40 CFR Part 264.111(b)	Human health and environment must be protected
40 CFR Part 268	Land disposal restrictions
National Environmental Policy Act (NEPA) (40 CFR Parts 1500-1508)	Requires consideration of environmental factors in Federal actions and providing public disclosure of proposed actions
EPA Designation, Reportable Quantities and Notification (40 CFR Part 302)	Specification of these requirements for hazardous substances under CERCLA
Clean Water Act National Pollutant Discharge Elimination System (NPDES) Program Requirements (40 CFR Part 122)	Requirements include discharge monitoring with records and compliance with water quality standards
Department of Transportation (DOT) Rules for Transportation of Hazardous Wastes (49 CFR Parts 170-172, 175, 178-179 and 262)	Requirements for packaging, preparing, labeling, manifesting, and transporting hazardous materials
STATE	
Industrial Solid Waste and Municipal Waste (31 TAC Chapter 335)	Regulations and standards for handling and Hazardous disposal of industrial solid and municipal hazardous wastes
Texas Water Code	Requirements for discharge of waste into or adjacent to waters in the state
TBCs	
52 FR 8712 (March 19, 1987) (Proposed rule)	Hybrid closure (Closure with waste in place) for removal of majority of contaminated materials. Addresses postclosure monitoring based on exposure pathways of concern
EPA Groundwater Protection Strategy	Policy direction for EPA programs with groundwater responsibilities

TABLE C-3

LOCATION-SPECIFIC ARARs

Reference	Description
FEDERAL	
Endangered Species Act (16 USC 1531, et seq.) and (50 CFR Parts 17, 226 and 227)	Requires action to avoid jeopardizing the continued existence or habitat of listed endangered or threatened species
Clean Water Act (Section 404) and (40 CFR Part 230 and 33 CFR Parts 320-330)	Requirements that involve discharge of dredge or fill material into wetlands. No activity which affects a wetland will be permitted if a practicable alternative that has less effect is available
Archaeological and Historic Preservation Act (16 USC 469a-c) and (40 CFR 6.301)	Requires that alteration of terrain which might cause irreparable loss or destruction of significant scientific, prehistoric, historic, or archaeological data be surveyed. The Secretary of the Interior must be advised of the presence of such data
National Historic Preservation Act (16 USC 470a-w) and (36 CFR 800 and EO 11593)	Requires identification, determination of effects of proposed actions on federally owned, administered or controlled prehistoric or historic resources or the likelihood of undiscovered resources
Archaeological Resources Recovery Act of 1979 (43 CFR Part 7)	Requirements for steps that protect archaeological resources and sites on public land
RCRA Location Standards (40 CFR Part 264.18)	Requirements for RCRA-defined listed or characteristic hazardous waste or constructing a RCRA facility within the 100 year floodplain
NEPA (40 CFR Part 6)	Policy for carrying out provisions of the Wetlands/Floodplains Management Executive Order. Requires that Floodplains Assessment be incorporated with the RI/FS
STATE	
(TAC Section 67.001, et seq.)	Requirement that actions which may jeopardize an endangered or threatened species or its habitat must be avoided or mitigated. (Consultation with the responsible state agency is strongly recommended for on-site actions)
Texas Civil Statutes (Title 26, art. 912a-1, et seq.)	Prohibits any thoroughfare across a cemetery dedicated under state law
TBCs	
Wetlands Executive Order (EO 11990)	Requirement that federal agencies minimize the destruction, loss or degradation of wetlands and preserve and enhance natural and beneficial values of wetlands
Floodplains Executive Order (EO 11988)	Requirements to reduce the risk of flood loss, minimize impacts of floods, and preserve the natural and beneficial value of floodplains

2.0 Technical Evaluation of Alternatives.

2.1 Introduction. During the review of each alternative technology, a summary of its effectiveness for protecting public health will be prepared. Each alternative will be evaluated to determine the extent to which it meets, exceeds or falls short of the ARARs. The analysis for each alternative will involve discussion of the technical issues including contaminant control and minimization, estimated time required to achieve ARARs; and the degree to which the technology is proven for the proposed application. Potential routes of exposure to contaminants during the remedial actions will be addressed along with the ARARs. If an alternative technology cannot attain an ARAR, it will be examined to determine its' potential to reduce the present or future threats to any identified receptors.

2.2 Identification and Screening of Remedial Technologies. A list of potential remediation technologies for both on-site and off-site remedies will be developed for the general response actions below:

- No action
- Containment
- Pumping
- Collection
- Complete Removal
- Partial Removal
- On-site Treatment
- In-situ Treatment
- Storage
- On-site Disposal
- Off-site Disposal
- Other off-site measures

This list of technologies will then be narrowed through an initial screening process based on known site conditions, waste characteristics, and technical requirements. Those technologies which are difficult to implement; require unreasonable time periods, or rely on unproven methods will be eliminated. Special consideration will be given to technologies that permanently contain, immobilize, destroy, or recycle contaminants, and technologies that promote energy recovery.

Waste characteristics that limit the effectiveness or feasibility of the remedial technologies will also be identified in this process. Such characteristics include: (1) physical properties such as volatility, solubility, and density; (2) specific chemical constituents such as chlorinated organic chemicals or metals; and (3) properties that determine the waste's toxicity or degree of hazard, such as persistence, acute toxicity, and ignitability. Technologies clearly limited by waste characteristics should be eliminated from consideration.

2.3 **Development of Alternatives**. During this task, the potential technologies for each of the general response actions will be developed and compiled into comprehensive, site-specific remediation alternatives. Emphasis will be placed on long-term mitigation potential and protection of public health and the surrounding sensitive biological areas. the development of alternatives will be consistent with EPA guidance in Section 300.68 of the National Contingency Plan and the requirements of other federal and state regulations.

In the development of remedial alternatives, consideration will be given to recycle, reuse, waste minimization, destruction, or other advanced, innovative, or alternative technologies, if appropriate. As part of the study, at least one alternative for each of the following will be evaluated:

- Alternatives for treatment or disposal at an off-site facility approved by EPA (including Resource Conservation Recovery Act RCRA), Toxic Substance Control Act (TSCA), Clean Water Act (CWA), Clean Air Act (CAA), Marine Protection, Research and Sanctuaries Act (MPRSA), and Safe Drinking Water Act (SDWA) approved facilities), as appropriate.

- Alternatives which attain applicable or relevant and appropriate Federal public health or environmental standards.

- As appropiate, alternatives which exceed applicable or relevant and appropriate public health or environmental standards.

- Alternatives which do not attain applicable or relevant and appropriate public health or environmental standards but will reduce the likelihood of present or future threat from the hazardous substances. This will include an alternative which closely approaches the level of protection provided by the applicable or relevant standards and meets CERCLA's objective of adequately protecting public health, welfare, and environment.

- A no action alternative

As part of the feasibility study, alternate contaminant levels (ACLs) of potential contaminants may be proposed. An ACL may be established for any contaminant upon a determination that the ACL will not be a substantial hazard to human health or the environment as long as the ACL is not exceeded. THE ACLs will be based on a demonstration that there is a lack of exposure or that levels of exposure are adequate to protect human health. In establishing ACLs, isolation, degradation, and dilution of the contaminants before they reach receptors will be considered.

2.4 Screening of Alternatives. Screening of the alternatives identified above will be undertaken. The objective of this screening will be to eliminate any alternatives that are clearly not feasible, appropriate, or competitive with other alternatives because of environmental considerations, engineering considerations, or cost. The following paragraphs provide a brief discussion of three factors that will be considered during the screening of alternatives.

2.4.1 Environmental Effects and Environmental Protection. The potential for adverse environmental or public health impacts during implementation or during the service life will be evaluated for each alternative. Factors considered under this subtask will be the following:

(1) Comparison of expected rates of release of contaminants and exposure levels
(2) Minimizing the disruption of habitat
(3) Aesthetic considerations
(4) Public acceptance and institutional and legal issues

Alternatives which have significantly greater risks or environmental impacts than other alternatives will be eliminated.

2.4.2 Implementation and Reliability. Alternatives will be reviewed to determine the ease of implementation and the proven reliability of the technologies. Alternatives that rely on technologies which are unproven, are unduly complex, require unreasonable time periods, institutional and legel requirements, or are prone to construction or operational error will be considered for elimination.

2.5 Technical Evaluation of Alternatives. For all past hazardous waste disposal and spill sites investigated at Carswell AFB, with the exception of those where a Finding of No Significant Impact (FONSI) is applicable, the data and conclusions obtained from the hydrogeological survey, site characterization, and qualitative risk assessment will be used to technically evaluate the preferred alternative remedial actions.

Remedial alternatives will be developed based upon the technologies remaining after the initial screening. Alternatives developed will include the five following categories:

(1) Alternatives for off-site treatment or disposal

(2) Alternatives that attain ARARs

(3) Alternatives that exceed ARARs

(4) Alternatives that do not attain ARARs

(5) No Further Action

Furthermore, alternatives outside of these categories may also be developed, such as non-cleanup alternatives (e.g. alternative water supply, relocation, etc.)

If applicable, the technologies will be grouped into operable units (OUs). An operable unit is a discreet part of the entire response action that decreases a release, threat of release, or pathway of exposure.

Documentation of the remedial alternative development process, including the decision rationale, along with the finalized list of preliminary remedial alternatives will be included in the final report.

2.5.1 <u>Institutional Requirements Evaluation</u>. The institutional factors associated with each alternative will be defined and the requirements of each identified. These include identifying applicable regulatory requirements, permits needed and participating agency cooperation. In addition, potential for public acceptance of each alternative will be estimated.

2.5.2 <u>Exposure Assessment</u>. Each alternative will be qualitatively assessed in terms of its' ability to minimize public exposure to residual contamination both during and after completion of the remedial action. Estimates of residual contamination and further reduction over time will be made for each alternative and compared to the no action alternative. Short-term exposure mechanisms will also be identified. Where appropriate, reductions in impact will be determined by comparing residual levels to existing criteria, standards or guidelines.

2.5.3 <u>Environmental Impact Evaluation</u>. The environmental impacts of each of the alternative remedial actions will be assessed. This will provide information on impacts and measures to mitigate these impacts for each of the alternatives. Both short-term implementation impacts and long-term impacts will be considered. An evaluation of beneficial impacts will also be included.

2.5.4 <u>Cost Analysis of Selected Alternatives</u>. Cost as a screening factor will only be used to differentiate technologies which provide similar results. At this stage in the development of the remedial alternatives, the engineering design of alternatives is quite general, so cost estimates will be approximations. Such approximations will be developed on a consistent basis, however, so that comparisons of these costs will be useful in comparing the cost-effectiveness of alternatives. A technology which will result in the destruction or reduction of a waste's mobility, toxicity and volume (MTU), although it may have a high capital cost, should not be eliminated. Alternatives which are more expensive than other alternatives without significant compensating advantages will be eliminated.

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DATA MANAGEMENT PLAN

1.0 <u>Data Management</u>. The field investigations will generate large amounts of data on the hydrogeology and chemistry of the study sites. Therefore, the data will be managed through a computerized database system which will be used to convert the raw field data and analytical data into usable forms for reporting. In addition, this will support the Air Force Installation Restoration Program Information Management System (IRPIMS) and data formats. The database will be designed to support the following activities:

(1) Archive, analyze and manipulate physical, chemical, biological and geological data collected during the IRP program.

(2) Analyze data with respect to trends or violations of environmental protection guidelines.

(3) Produce subsets of data to form summary reports and data files which can be analyzed by environmental models and statistical algorithms.

(4) Interpret relationships between contaminant migration and biogeochemical relationships existing at a particular site.

2.0 <u>Predefined Codes</u>. As part of the data management, the documentation and procedures used during collection of sampling data will follow appropriate protocols and guidelines to eliminate data gaps. Data will be classified according to guidelines that will use predefined codes from the Air Force. The coded values will minimize the size of the database and will reduce the time needed to perform the data entry effort.

3.0 <u>Data Collection Forms</u>. Data collection forms will be provided by the Air Force and will be revised to record data gathered by field personnel or measurements performed by laboratory technicians.

4.0 Automated Data Processing (ADP) Format. In the Air Force specified ADP format all technical data, including site information, well characteristics, hydrogeologic, geologic, physical and chemical sampling results will be stored on magnetic media (floppy disk or magnetic tape.) The technical data will be organized in flat files using data files specified in an acceptable Air Force format.

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